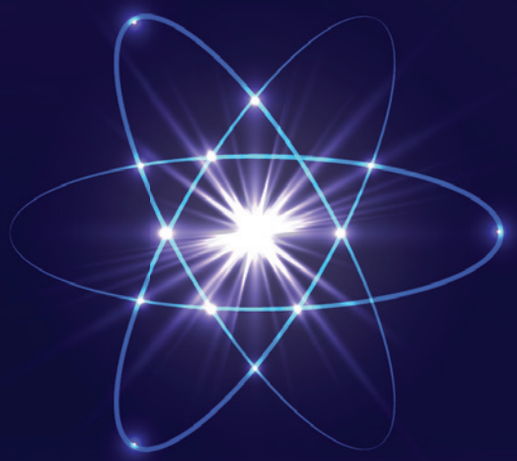
NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

Mission and Vision

FY2019–FY2028

The Mission and Vision of the
United States Department of Energy
Nuclear Criticality Safety Program



U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

ORNL 2019-G00049/AM

Preface

The US Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) is chartered with maintaining the technical infrastructure necessary to ensure safe, efficient operations from a criticality safety perspective. The NCSP and its initiatives have been planned and executed annually through a series of updates to a rolling five-year plan. The NCSP's Mission and Vision for the next five to ten years facilitates development of a coherent, integrated implementation plan, and the five-year execution plan has been developed to achieve NCSP's five-year vision. Revised editions of the five-year plan will continue to serve as the roadmap to achieve NCSP's goals as described herein. Ten years have passed since the original FY2009–FY2018 Mission and Vision was published. Every five years, the Mission and Vision is revisited, and the current ten-year goals and attributes are revised to reflect progress over the previous five years. This living document provides the planning basis for all funding and initiatives undertaken by the NCSP, and it defines NCSP's values and operating culture.

Nothing is more fundamental to operations with fissionable material than criticality safety. Ensuring that a criticality accident never happens again in a DOE facility is one key objective of the DOE mission supporting the national security and energy needs of the United States. It is with this ultimate goal in mind that this revision of NCSP's Mission and Vision is dedicated and approved.

Approved:

February 28, 2019

Dr. Angela S. Chambers
Nuclear Criticality Safety Program Manager
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National Nuclear Security Administration

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1. Nuclear Criticality Safety Program Mission, Vision, and Values

1.1. Introduction

1.1.1. Nuclear Criticality Safety Program

The Nuclear Criticality Safety Program (NCSP) is funded by the National Nuclear Security Administration (NNSA), a semiautonomous agency of the US Department of Energy (DOE). Dr. Angela Chambers (NA511) is the NCSP Manager. Regarding technical matters, she is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG), and for DOE field criticality safety issues, she is supported by the Criticality Safety Coordinating Team (CSCT), which consists of federal criticality safety practitioners at the sites regarding DOE field criticality safety issues. Charters for the CSCT, CSSG, and the NDAG can be found on the NCSP website at http://ncsp.llnl.gov/.

The NCSP mission is to provide sustainable expert leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support safe, efficient fissionable material operations within DOE.

The NCSP vision is to be a continually improving, adaptable, and transparent program that communicates and collaborates globally to incorporate technology, practices, and programs to be responsive to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

The NCSP Mission and Vision is achieved by identifying and accomplishing a set of five-year programmatic goals that correspond with five broad technical program elements supporting the identified ten-year goals. The NCSP Five-Year Plan defines tasks designed to accomplish specific goals identified in the NCSP Mission and Vision. The current Five-Year Plan has been developed to accomplish these mission and vision goals with the advice and assistance of experts appointed by the NCSP manager or working under charters approved by the NCSP manager. The five technical program elements are:

- Analytical Methods (AM)
- Information Preservation and Dissemination (IPD)
- Integral Experiments (IE)
- Nuclear Data (ND)
- Training and Education (TE)

An additional program element is Technical Support (TS), which provides daily execution management support for the NCSP, site scope, and deliverable tracking via site task managers (TMs), along with technical advisement from the CSSG, CSCT, and NDAG to the NCSP Manager. Figure 1 illustrates the NCSP technical elements and technical support capabilities.

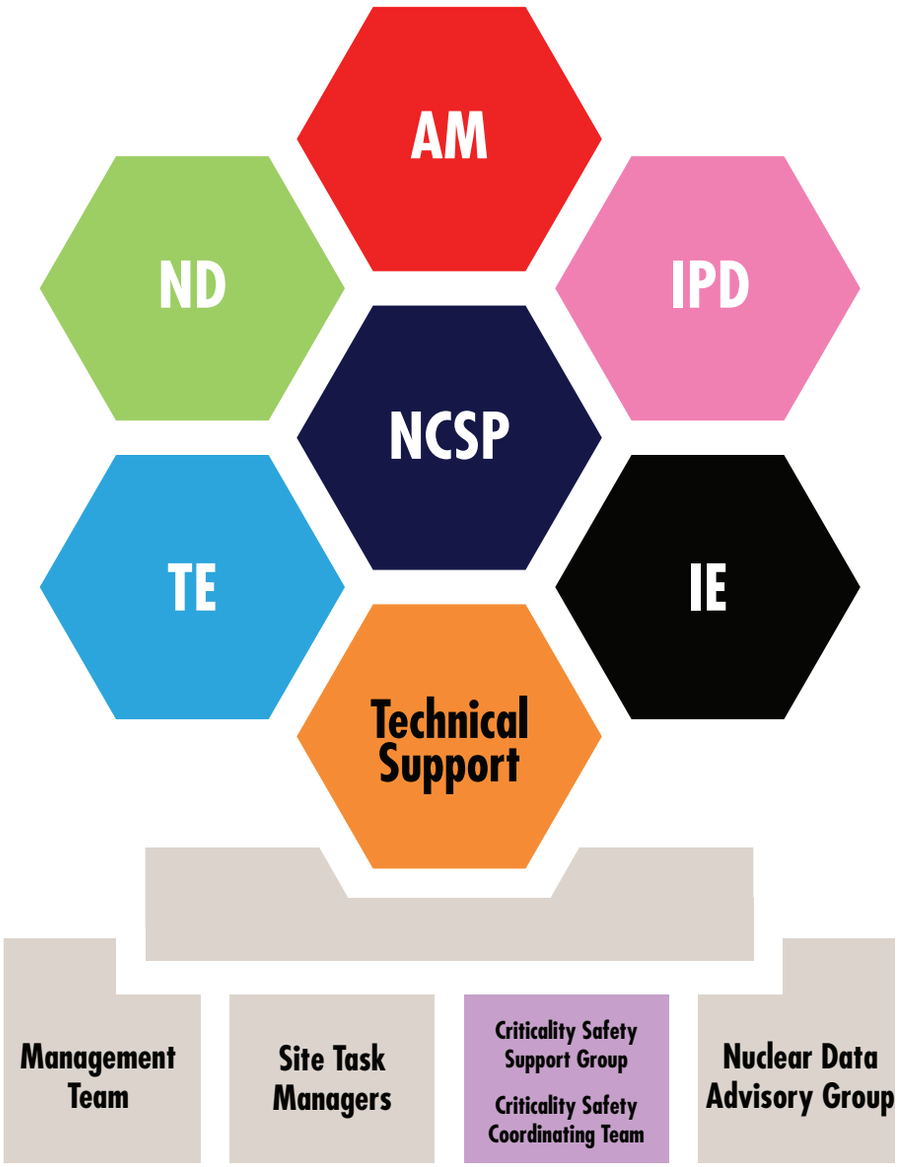


Figure 1. NCSP Technical Program elements and structure.

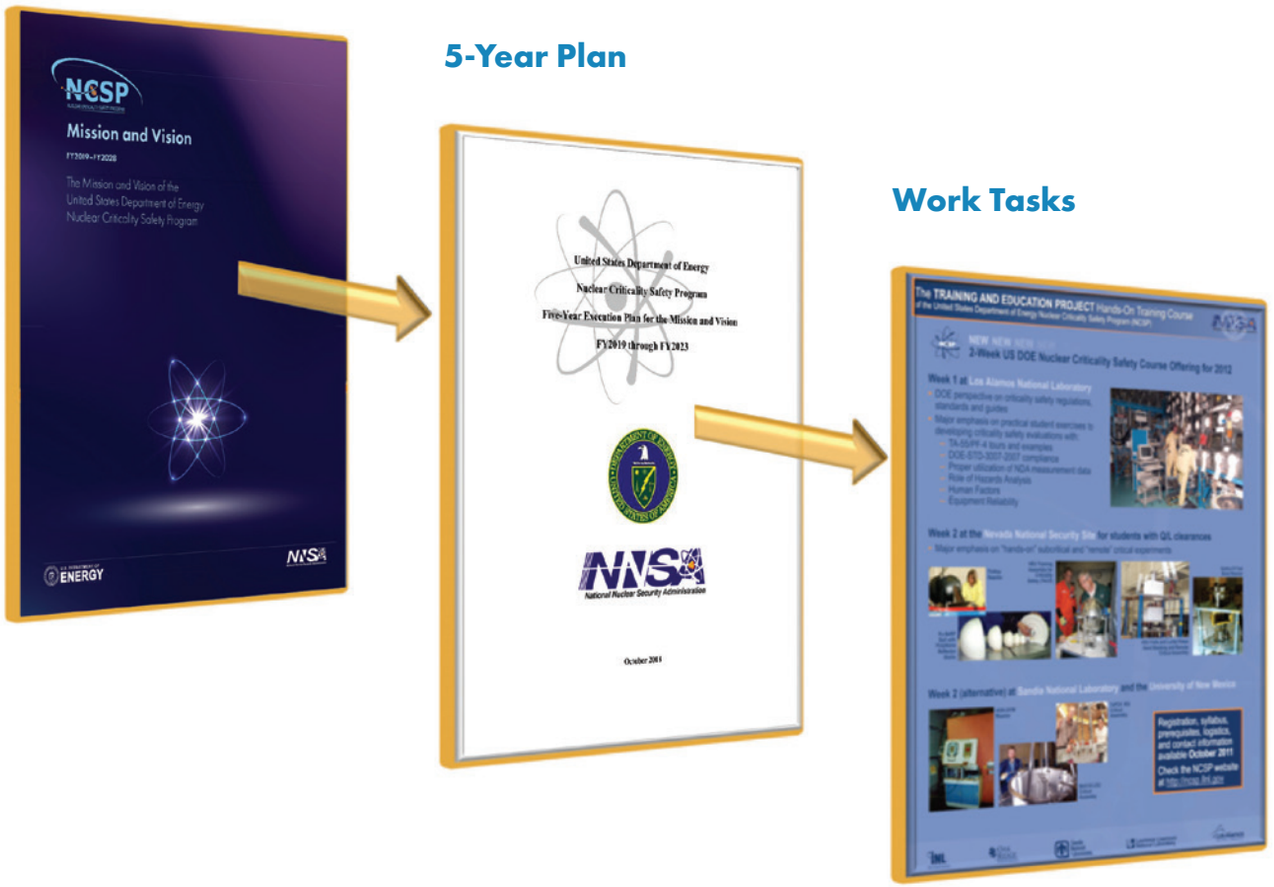


Figure 2. NCSP Mission and Vision implimentation into site-level tasks.

The NCSP Mission and Vision provides specific goals for each program element. Each task in the current Five-Year Plan aligns with a specific NCSP Mission and Vision goal. The goals and attributes defined herein are implemented via an NCSP 5-Year Execution Plan that defines site work scope, budget, and deliverables, all of which are updated annually. Figure 2 illustrates this process, and Figure 3 presents the NCSP mission, vision and values statements.

1.2 Mission, Vision, Values

Mission

The NCSP mission is to provide sustainable expert leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support safe, efficient fissionable material operations within the DOE.

Vision

The NCSP will be a continually improving, adaptable, and transparent program that communicates and collaborates globally to incorporate technology, practices, and programs to be responsive to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

Values

Continual Improvement – The NCSP assesses its products and processes.
Adaptability – The NCSP encourages innovation.
Transparency – The NCSP discloses its plans, processes, and accomplishments.
Communication – The NCSP dialogues with its stakeholders.
Collaboration – The NCSP engages national and international resources.
Responsiveness – The NCSP responds to the needs of its DOE stakeholders.
Sustainability – The NCSP prepares the next generation of technical leaders.
Expertise – The NCSP involves world-class criticality safety experts.
Safety – The NCSP resolves any threat to criticality safety.
Efficiency – The NCSP tailors solutions to maximize efficiency.
Operations – The NCSP adopts DOE missions and goals as its own.

Figure 3. Summary of the NCSP Mission, Vision, and Values.

2. NCSP Mission and Vision Implementation

2.1. Strategy

The NCSP Mission and Vision will be achieved by identifying and accomplishing the five-year programmatic goals in the AM, IPD, IE, ND, and TE technical program elements that support the identified ten-year goals. The NCSP Five-Year Execution Plans published annually to accomplish these goals are developed (1) with the advice and assistance of experts appointed by the NCSP manager and (2) by working under charters approved by the NCSP manager.

The following sections identify the mission, vision, strategy, and goals for each of these technical program elements as they relate to the overall NCSP Mission and Vision. Each section lists the specific attributes and goals to be attained by the end of Fiscal Year 2023. Detailed lists of attributes (a quality or characteristic; a distinctive feature), and five- and ten-year goals for each element have been developed to support the NCSP Vision and are detailed within each program element.

Each NCSP technical program element has associated attributes and goals to achieve its vision, as shown in the tables below. Budget and technical priority rankings are based on current and projected budgets, as well as technical goals established for the next 5 and 10 years. Color coding for priority rankings in the attribute and goal tables are shown in Figure 4.

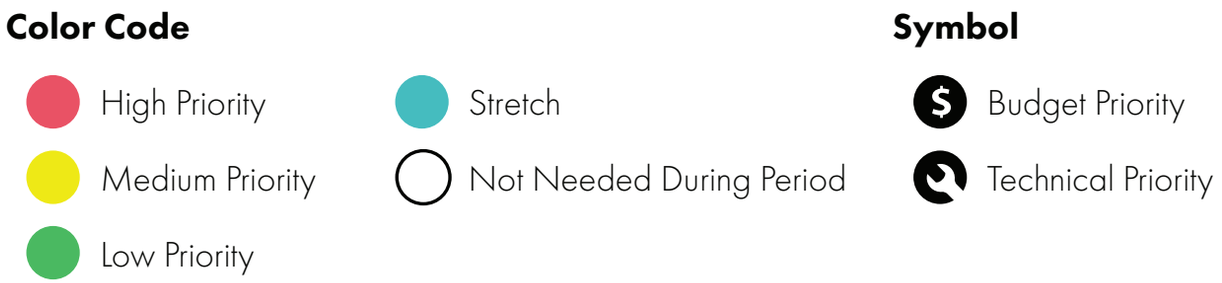


Figure 4. Technical and budget priority key for the attribute and goal tables.

2.2. Assessment of FY2009–2018 Mission and Vision Attributes and Goals

The purpose of this midterm review of the first NCSP Mission and Vision document for fiscal years 2009–2018 is to assess progress in meeting the goals established in the first document and to provide a road map for continuing to improve the criticality safety infrastructure necessary to ensure safe, efficient operations from a criticality safety perspective. Many of the goals in the first Mission and Vision document have been met, and each program element description below highlights some of the accomplishments. Noteworthy accomplishments during the last five years include the following:

- Utilization of the four critical assemblies in the new National Criticality Experiments Research Center (NCERC) in Nevada
- Water-moderated critical experiments capability at Sandia National Laboratories (SNL) in Albuquerque, New Mexico, to support training for nuclear criticality safety (NCS) engineers and managers
- Subcritical, delayed critical, and prompt supercritical experiments
- Extensive development, maintenance, and modernization efforts of NCSP-supported code packages such as MCNP, SCALE, SAMMY, AMPX, and NJOY, providing NCS practitioners, nuclear data analysts, and others with state-of-the-art tools to support their important work

This current, updated Mission and Vision document for FY2019–FY2028 is organized in the same manner as the previous version: each program element section flows from the mission, vision, and attributes of a robust program element to five-year, ten-year, and stretch goals that, if met, will help sustain the attributes of a robust program. Attributes and goals tables are color coded to depict a consensus of technical and budget priorities. Future versions of this document will continue to define the framework for the NCSP five-year planning process.

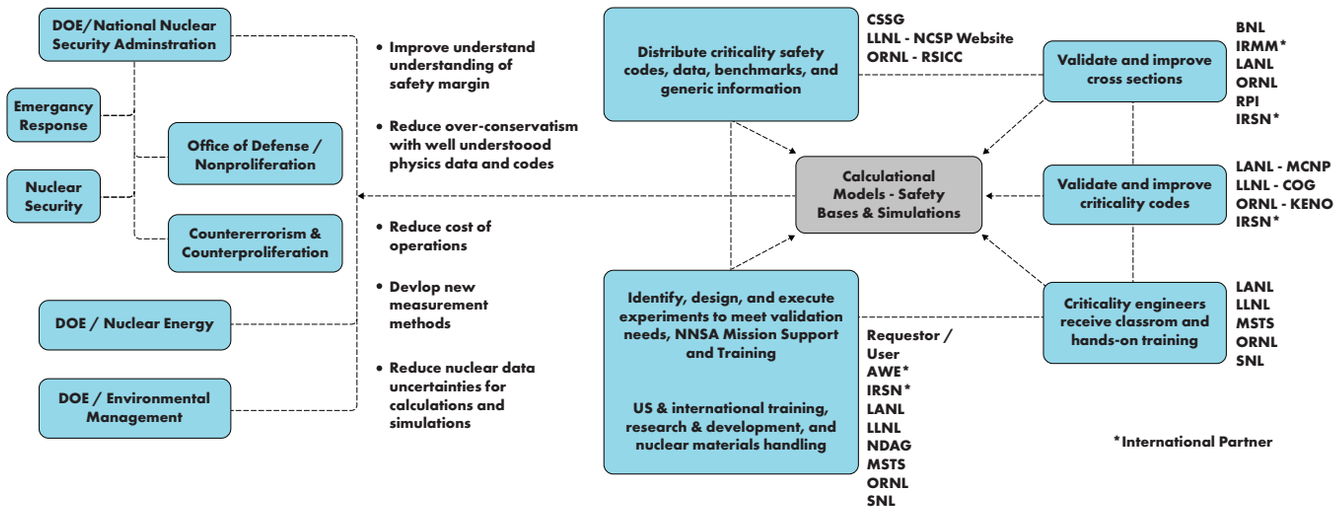


Figure 5. Components of the NCSP.

3. Analytical Methods (AM)

3.1. AM Mission

The Analytical Methods (AM) program element provides for development and maintenance of state-of-the-art analytical capabilities for the processing of nuclear data from the evaluated nuclear data file (ENDF) and the radiation transport analysis needed to predict system k-effective values and other quantities of interest, as well as analytical tools to support practitioners. An essential aspect of this capability is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community.

3.2. AM Vision

The AM element will sustain state-of-the-art radiation transport modeling capabilities and the expertise necessary to develop, maintain, and disseminate production level analytical tools and data libraries in a manner that is responsive to the needs of those who develop, implement, and maintain criticality safety.

3.3. AM Strategy

The following strategy has been developed to direct the AM element toward achieving its vision. The AM element will:

- Actively engage the criticality safety practitioners to identify their AM needs through various means of communication and to develop and implement capabilities to meet those needs.
- Provide and support radiation transport codes and tools containing rigorous physics models, efficient solution algorithms, sophisticated and user-friendly modeling capabilities, comprehensive outputs to facilitate user understanding, and methods to perform sensitivity/uncertainty (S/U) analyses.
- Provide and support data processing codes and tools containing rigorous physics models to produce the data libraries required by the transport codes from cross section evaluations.
- Provide products that are developed and maintained in accordance with modern software quality assurance (SQA) practices and that are adaptable to meet changing criticality safety user needs and computing environments.
- Implement various mechanisms to support criticality safety users, including user education and training, newsletters, user forums, phone and e-mail consultation, and a well-defined tool for timely distribution of software and data libraries.
- Sustain the NCSP analytical capabilities and expertise through continual improvement of methods and mentoring of the next generation of experts, especially through leadership and engagement with international partners.
- Identify and communicate nuclear data needs based on validation activities and user feedback.

3.4. AM Technical Gap

Most of the previous 5-year goals were partially met and are ongoing. Previous goals which were not completed related to real-time analysis of accidents, extension of covariance data, and linkage of transport codes to computer-assisted design (CAD). Significant progress was made during the past 5 years to improve SQA. Some technical gaps to be addressed in the next 5- and 10-year periods include processing code support for the new Generalized Nuclear Data Structure (GNDS) format, as well as supporting additional reaction channels and associated covariance data to improve the reliability and predictiveness of S/U analysis tools. New AM goals to be addressed in the next 5- and 10-year periods include development of a covariance methodology for thermal scattering law (TSL) data, a covariance methodology for unresolved resonance range (URR) data, temperature correction for covariance data, improved physics fidelity, temperature dependence, easier support for sources, detector responses, coincidence counting, and list mode data.

Table 1. AM Budget and Technical Priority Rankings

Attributes	Goals	5y	10y
Personnel			
Cross section processing developers	Develop and implement succession plans to maintain cross section processing expertise	$	$
Radiation transport developers	Develop and implement succession plans to maintain radiation transport expertise	$	$
User support specialist	Develop and implement succession plans to maintain radiation transport expertise	$	$

Table 1. AM Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Processing codes and data libraries			
Ability to process • Input evaluations in standard formats from all international compilations • Reaction cross section/energy/angle • Covariances (reaction/energy/angle)	Develop and maintain more than one independent cross section processing code system	$	$
	Update processing codes to process new, modern ENDF-6 and GNDS data format	$	$
	Process new covariance evaluations for thermal scattering law data, collision kinematics, fission energy distributions	$	$
Ability to create code-dependent libraries • Continuous-energy • Multigroup	Produce continuous-energy, multigroup, and covariance data libraries for use in radiation transport code systems	$	$
SQA of processing codes and libraries	Develop and maintain processing software and data libraries under SQA	$	$
	Develop and utilize comprehensive verification/validation suite to allow cross-code comparison of processing results from ENDF formats	$	$
Computational • Multiplatform • Multiple operating systems, compilers • Adaptable, sustainable (languages, etc.)	Deploy cross section processing code systems for operation on multiple computing platforms and operating systems	$	$

Table 1. AM Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Radiation transport codes			
Solution method • Monte Carlo • Deterministic • Coupled Monte Carlo-Deterministic • Solution efficiency/accuracy	Develop and maintain more than one independent radiation transport code system	$	$
	Develop and maintain coupled Monte Carlo-Deterministic capabilities to enable automated variance reduction capabilities	$	$
	Develop and maintain modern source convergence and variance reduction methods	$	$
Geometry • 1D → generalized 3D • CAD/computer-aided engineering (CAE) interface • Time dependence (e.g., Godiva ringing)	Provide and maintain radiation transport software with geometry modeling capabilities (1D to 3D) needed to support NCS analyses	$	$
	Couple modern NCS radiation transport software with CAD/CAE packages	$	$
	Develop and maintain time-dependent geometry modeling capability	$	$

Table 1. AM Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Radiation transport codes (continued)			
Physics • Coupled neutron, photon • Eigenvalue/fixed source • Forward and adjoint • Time-dependent • Continuous-energy • Fine group, problem-dependent multigroup • Subcritical techniques • Depletion capability • Temperature dependence and feedback	Provide and maintain radiation transport software with the following capabilities to support NCS analyses: • Coupled neutron, photon transport • Eigenvalue/fixed source solution • Forward and adjoint solution • Continuous-energy and multigroup solution	$	$
	Develop and deploy time-dependent radiation transport accident analysis capabilities	$	$
	Develop and maintain NCS radiation transport software with temperature feedback	$	$
Ease of use • Documentation, including limited online help • Graphical user interface • Interoperability • Materials preprocessing	Develop and maintain the following capabilities: • Documentation, including limited online help • Graphical user interface • Interoperability • Materials preprocessing	$	$
	Provide regular training courses each year on use of NCS software	$	$
Radiation transport software with modern output and modularity to facilitate NCS analyses	Develop and maintain NCS radiation transport software with the following capabilities: • Ability to link to other physics codes • Detailed physics edits, including detectors • Modern markup language (e.g., HTML) • Graphical displays • Flux, reaction rate edits • Generic multiphysics output (e.g., ABACUS)	$	$

Table 1. AM Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Radiation transport codes (continued)			
SQA of transport codes	Develop and maintain radiation transport software and data libraries under SQA	$	$
Computational • Multiplatform • Multiple operating systems, compilers • Adaptable, sustainable (languages, etc.)	Deploy radiation transport systems for operation on multiple computing platforms and operating systems	$	$
S/U methods			
Sensitivity analysis capabilities • Sensitivity profiles • Similarity assessment • Covariance data (differential, integral, computational)	Develop and maintain more than one independent S/U analysis software package	$	$
	Develop and deploy methods to provide integral experiment correlation data	$	$
	Provide correlation data for integral benchmark experiments	$	$
	Develop and maintain a S/U analysis methodology using TSL covariance data	$	$
Data assimilation	Develop and maintain S/U data assimilation capabilities to support uncertainty analysis and bias quantification	$	$

Table 1. AM Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
S/U methods (continued)			
Covariance adjustment	Develop and maintain S/U covariance adjustment capabilities per new CSEWG recommendation	$	$
Validation	Develop and maintain S/U capabilities to facilitate quantitative NCS validation analyses (e.g., similarity assessment, area of applicability determination, upper subcritical limit [USL] determination, etc.)	$	$
SQA of S/U codes	Develop and maintain radiation transport software and data libraries under SQA	$	$
Accident analysis			
Update SlideRule	Develop and maintain modern, accident analysis capability (SlideRule)	$	$
3D accident analysis capability	Develop and deploy time-dependent multiphysics capabilities: • Neutron transport • Temperature feedback • Hydrodynamics • Time-dependent geometry • Fluid-flow	$	$

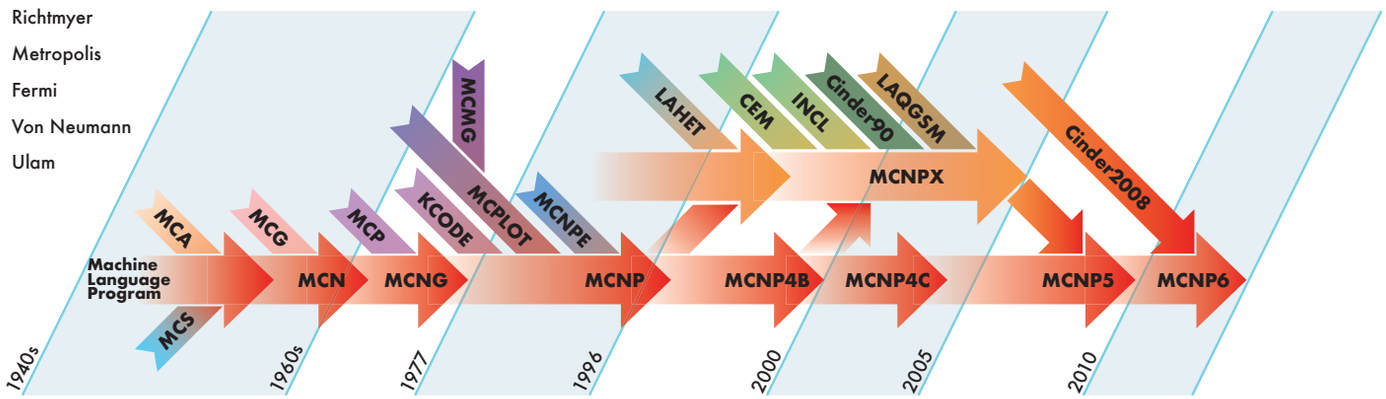


Figure 6. Evolution of MCNP transport code.

Modeling and Simulation Tools for Neutronics and Shielding Analysis

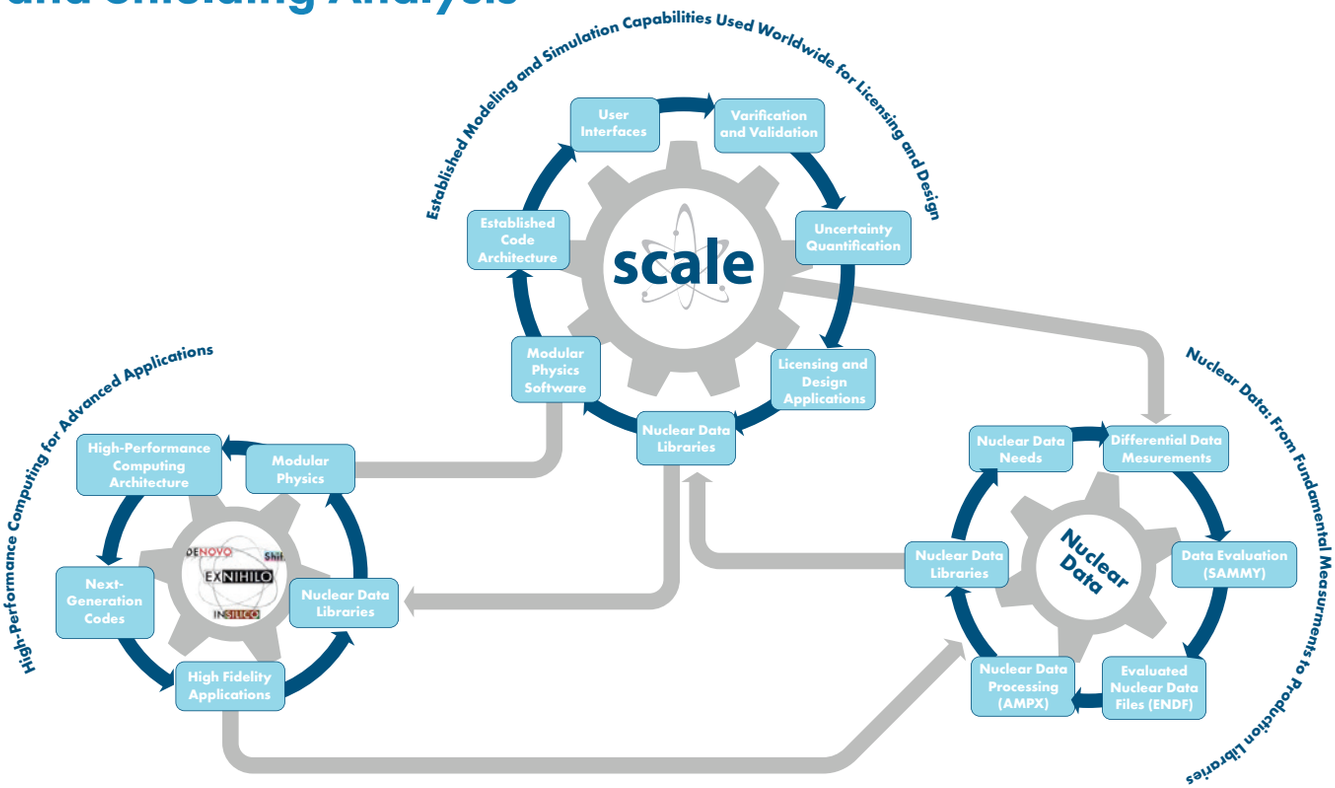


Figure 7. Modeling and simulation aspects of NCSP.

Energy-Dependent Sensitivities: ^{235}U and ^{238}U

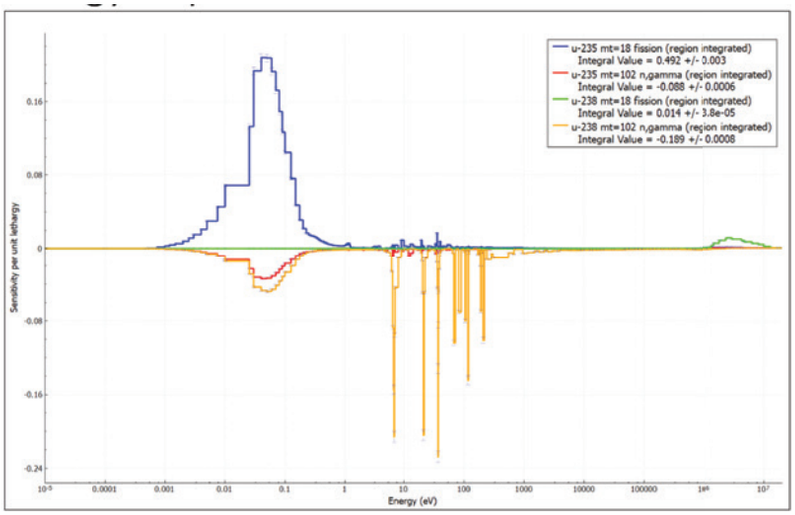


Figure 8. Sample TSUNAMI sensitivity plot.

4. Information Preservation and Dissemination (IPD)

4.1. IPD Mission

The Information Preservation and Dissemination (IPD) program element preserves primary documentation supporting criticality safety and makes this information available for the benefit of the technical community, including international partners (e.g., the Atomic Weapons Establishment [AWE], the Commissariat à l'Énergie Atomique [CEA] and the Organisation for Economic Cooperation and Development [OECD]) and the Institut De Radioprotection et De Sûreté Nucléaire (IRSN). The NCSP internet website (http://ncsp.llnl.gov) is the central focal point for access to criticality safety information collected under the NCSP and serves as the gateway to a comprehensive set of hyperlinks to other sites providing criticality safety information/resources. IPD includes documenting and preserving criticality safety benchmarks via the International Criticality Safety Benchmark Evaluation Project (ICSBEP).

4.2. IPD Vision

The IPD element will identify, preserve, and disseminate selected technical, programmatic, and operational information that enables those responsible for criticality safety to sustain, enhance, and continually improve performance in support of **safe, efficient** fissionable material **operations.**

4.3. IPD Strategy

The following strategy has been developed to direct the IPD element toward achieving its vision. The IPD element will:

- Establish a structured approach to using expert groups and individuals who will asist in identifying and selecting existing sources of organized information and other types of technical, programmatic, and operational information for preservation.
- Establish easily accessible unclassified repositories that can be sustained to provide for preservation and digital dissemination of the selected information.
- Maintain a classified repository (historical/future) as needed for programmatic support.
- Conduct succession planning to provide continuity of expertise and to prepare the next generation of leaders.

4.4. IPD Technical Gap

Most of the previous 5-year goals were partially met and are ongoing. Several have been deleted, as they proved to have no value identified. Goals not met include the following: (1) develop a repository for all evaluations/reports associated with criticality safety from this point forward, (2) distribute approved criticality safety program description documents, and (3) develop a process for keeping the Criticality Safety Coordinating Team informed about emerging regulatory actions, impacts, and initiatives (DOE letters to contractors). These goals were removed due to unforeseen impracticalities and are being managed under different auspices external to NCSP. Removal of these goals has no negative impact on the IP&D Mission or Vision. Several goals have been identified as "Goal in progress. Will be carried forward" and were highlighted orange according to the NCSP color coding definitions.

Table 2. IPD Budget and Technical Priority Rankings

Attributes	Goals	5y	10y
Personnel/facilities			
Maintance/development of unclassified and classified web-based repositories with controlled access as needed for important data for criticality safety. Examples include but are not limited to: • ICSBEP benchmarks • Classified benchmarks • Critical experiment logbooks • Electronic handbooks and relevant criticality safety standards and data • Operational experience and training videos • Criticality safety professional phonebook	Implement and maintain periodic data call for available material: • Provide processes for evaluating available material for IP&D value • Archive and disseminate training and operational videos (historical and current) • Preserve unclassified/classified topical references (e.g., waste drums, vault storage, onsite/offsite transport, criticality alarm placement, D&D)	$	$
	Maintain NCSP website to improve user interface and data retrievability	$	$
	Operate and maintain a robust and secure infrastructure (e.g., web server hardware/software, NCERC "Red" network, etc.) to support information dissemination	$	$

Table 2. IPD Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Personnel/facilities (continued)			
Maintance/development of unclassified and classified web-based repositories, with controlled access as needed for important data for criticality safety. Examples include but are not limited to: • ICSBEP benchmarks • Classified benchmarks • Critical experiment logbooks • Electronic handbooks and relevant criticality safety standards and data • Operational experience and training videos • Criticality safety professional phonebook	Develop and maintain searchable criticality safety professional phonebook, include site/facility criticality safety point of contact (POC), include key words for experience/evaluation expertise		
			
	Implement a process to rapidly disseminate information (e.g., operational upsets, emergency response) to criticality safety professionals ("Crit spam")		
	Develop a long-term hardcopy archive of critical experiment logbooks (includes eventual electronic versions)		
			
	Maintain and publish (as an electronic newsletter) a US/International database of near misses, operational issues and lessons learned (historical/future)		
	Provide periodic reports on NCSP TPR to communicate and promote to the criticality safety related community (web-published and ANS session)		
	Identify and retain key data important to criticality safety, includes CS Handbook		
			

Table 2. IPD Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Personnel/facilities			
Partnership with national and international entities for data collection, evaluation and preservation	Participate in national and international ICSBEP information exchange programs and meetings	$	$
		↻	↻
	Within ICSBEP, evaluate and review evaluations to assess the quality of available data to ensure data consistency and communication of discrepancies, publish unclassified and classified criticality safety-related benchmarks including historical/future sensitivity studies	$	$
		↻	↻
Sharing of NCSP accomplishments and activities with the domestic and international NCS community, DOE, and other US agencies	Maintain a periodic NCSP newsletter that is posted on the NCSP website	$	$
		↻	↻

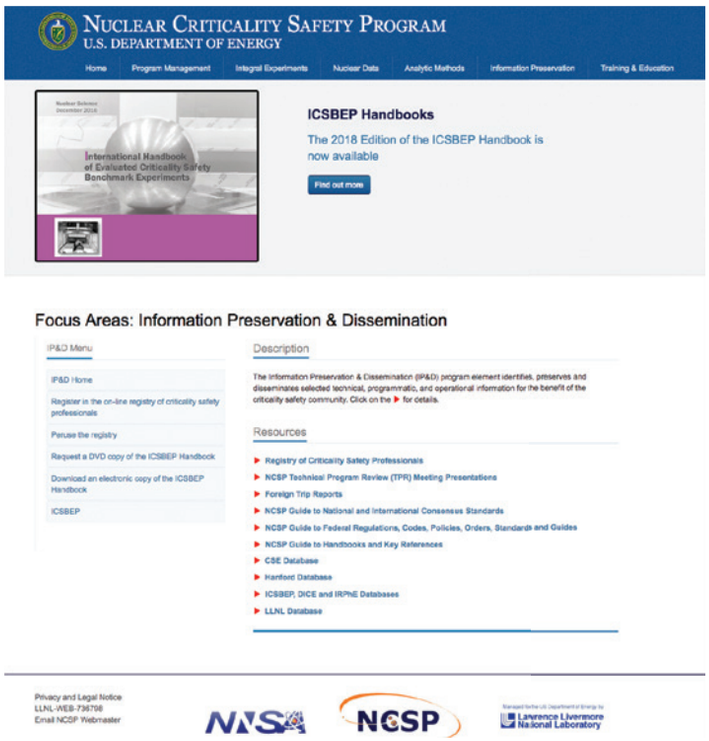


Figure 9. ICSBEP Handbook website.

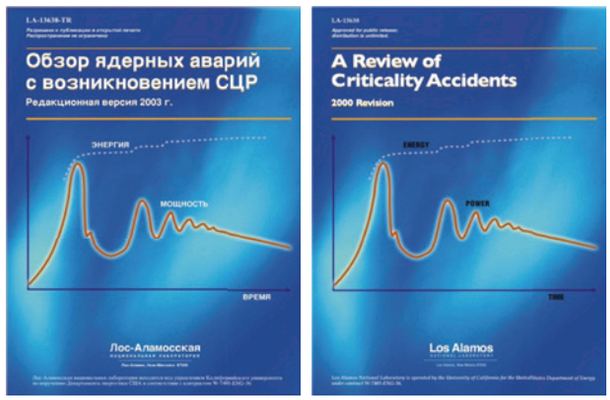


Figure 10. US/Russian collaboration on preservation of criticality accident information.

5. Integral Experiments (IE)

5.1. IE Mission

The Integral Experiments (IE) program element sustains and enhances a fundamental nuclear materials handling capability to conduct subcritical, critical, supercritical, prompt critical, and super-prompt critical fundamental physics experiments and training.

5.2. IE Vision

The IE element will serve as a national and international resource, providing a sustainable infrastructure including a systematic, interactive process to assess, design, perform, and document nuclear material experiments and training.

5.3. IE Strategy

The strategy outlined below has been developed to direct the IE element towards achieving its vision. The IE element will:

- Provide and sustain integral subcritical, critical, supercritical, prompt critical, super-prompt critical, and fundamental physics experiment capabilities.
- Sustain a systematic, interactive process for identifying, assessing, and continually improving an adaptable integral experiment infrastructure which incorporates personnel, programs, practices, technology, and facilities that provide the most efficient means of realizing the IE vision.
- Sustain a systematic and interactive process for identifying, assessing, and continually improving an adaptable integral experiment infrastructure for users from other DOE elements and international partners of non-NCSP operations customers.

5.4. IE Technical Gap

Many of the previous 5-year goals were partially met and are ongoing. However, technical gaps remain in the IE program element. Predominantly, these gaps are associated with (1) developing personnel as experimentalists and support personnel, (2) maintaining and expanding facilities to support experiments, (3) developing new experiment equipment, and (4) identifying and acquiring nuclear and non-nuclear materials to support experiments. Other goals that were not met and are being revised include development of the hot/cold machine shop, the rabbit system, the solution assembly, the general-purpose horizontal split table, radiochemistry/processing, the low scatter facility, and the remote material handling capability.

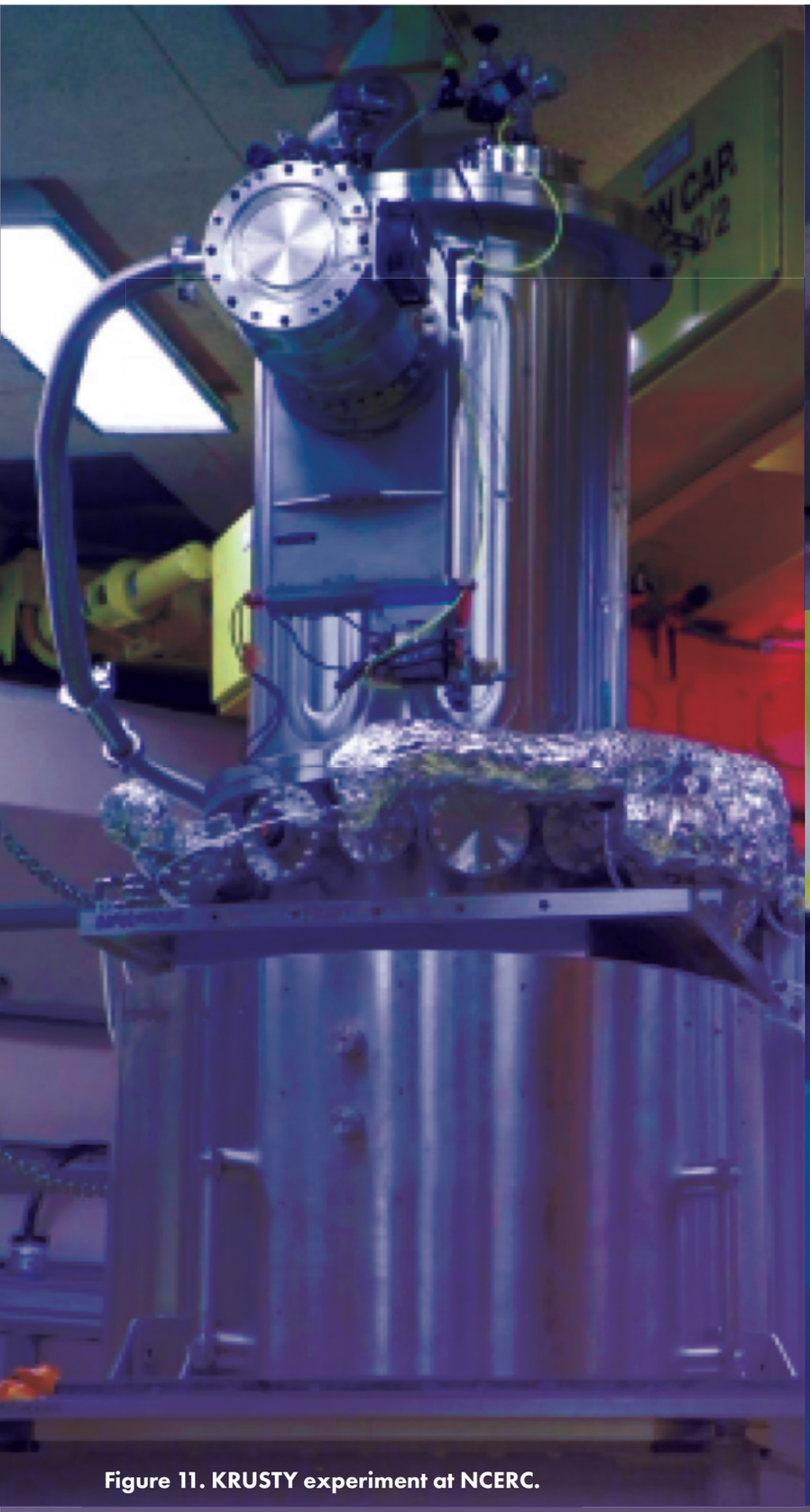


Figure 11. KRUSTY experiment at NCERC.

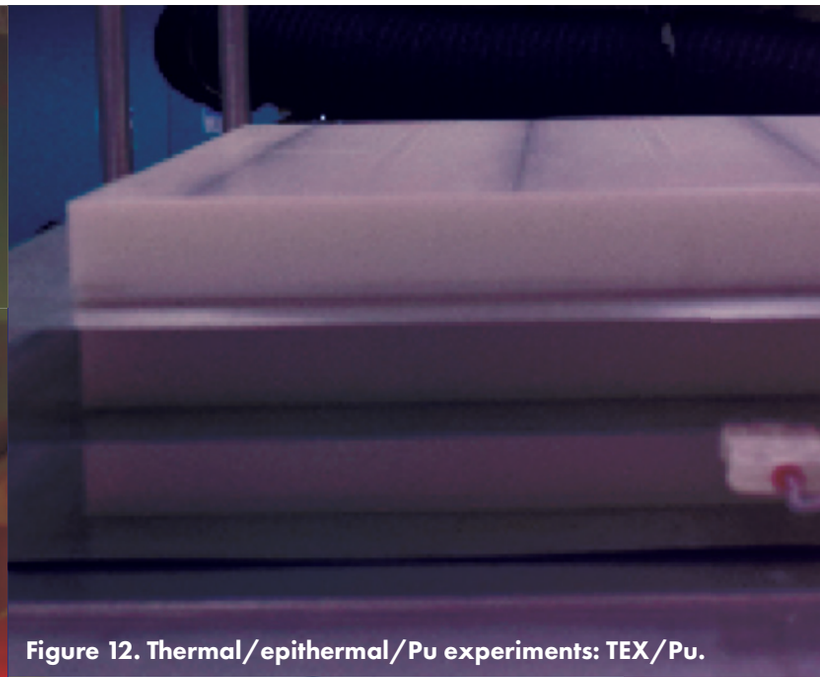


Figure 12. Thermal/epithermal/Pu experiments: TEX/Pu.

Figure 13. Subcritical copper-reflected alpha-phase plutonium experiment.

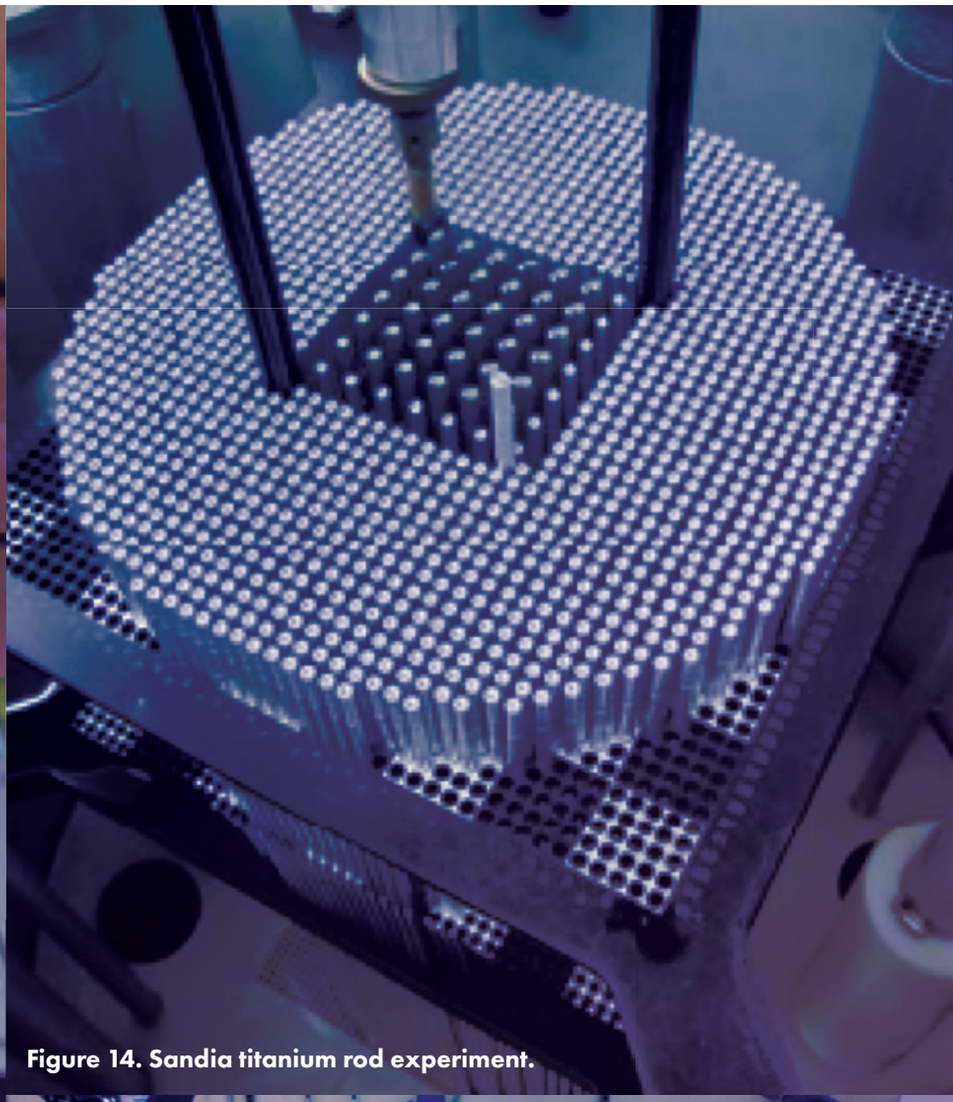


Figure 14. Sandia titanium rod experiment.

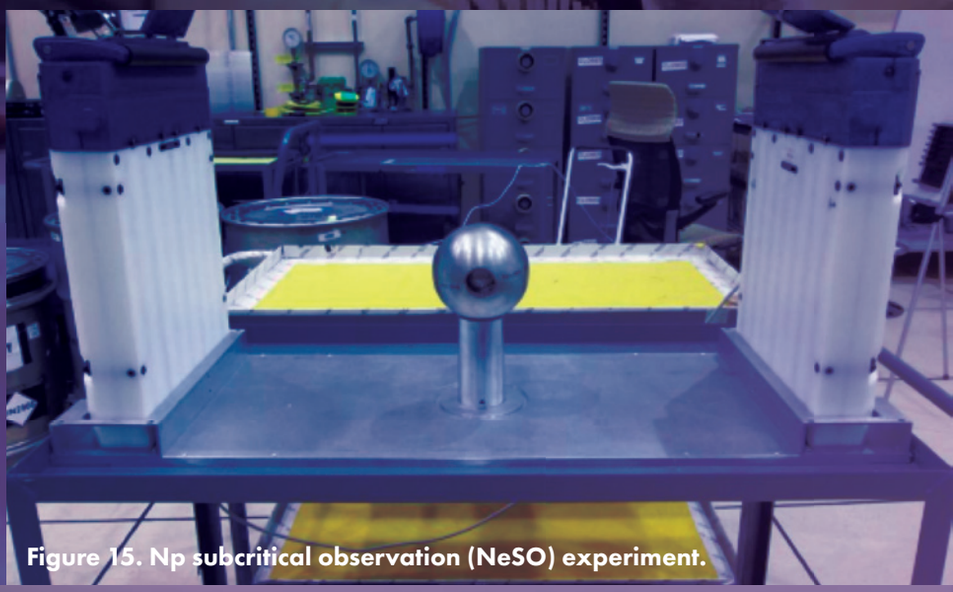


Figure 15. Np subcritical observation (NeSO) experiment.

Table 3. IE Budget and Technical Priority Rankings

Attributes	Goals	5y	10y
Personnel			
Experimentalists	Develop/implement succession plans	$	$
Equipment support personnel	Develop/implement succession plans	$	$
Facility support personnel	Develop/implement succession plans	$	$
Access to nonqualified personnel for training with all security category nuclear material operations	Sustain efficient access and escort of trainees at NCERC	$	$
Facilities			
Support for all security category nuclear material operations	Repair/maintain NCERC facility infrastructure to support IE mission	$	$
	Repair/maintain SNL facility infrastructure to support IE mission	$	$
	Acquire building capable of supporting modular (singular campaign mode) critical assemblies	$	$
Support for all nuclear material types and forms	Develop authorization basis to support powders and solutions	$	

Table 3. IE Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Facilities (continued)			
Low-scatter facilities	Design and deploy low-scatter capabilities		
Machine shop hot/cold	Standup cold machine shop at NCERC		
	Standup hot machine shop at NCERC		
Support for free-field experiments	Develop infrastructure to support free-field experiments		
Support for dynamic experiments	Develop infrastructure to support dynamic experiments		
Low-background counting area	Sustain		
Dosimetry laboratory	Sustain		
Radiochemistry laboratory	Design and deploy radiochemistry laboratory at NNSS		

Table 3. IE Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Experiment equipment			
General purpose vertical lift machine	Investigate vertical lift assembly for SNL	$	
		↻	
Horizontal split table	Construct horizontal split table	$	
		↻	
Fast burst reactor	Investigate restoring SPR-III to service	$	
		↻	
	Develop a conceptual design of a Np burst reactor	$	
		↻	
Solution reactor	Investigate solution reactor design and location	$	
		↻	
	Construct solution reactor		$
			↻
Uranium lattice light water moderated (CX)	Sustain	$	$
		↻	↻
Rabbit system	Design and install rabbit system at NCERC	$	
		↻	

Table 3. IE Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Experiment equipment (continued)			
Precision measurements	Acquire precision measurements instrumentation at NCERC	$	
		↻	
Fast benchmark assembly	Sustain	$	$
		↻	↻
	Design and build Jezebel	$	$
		↻	↻
Materials			
Nuclear: access to all nuclear material types and forms	Investigate acquisition of low-enriched metal (≤ 20% U)	$	
		↻	
	Investigate acquisition of Np metal	$	
		↻	
	Acquire Np metal		$
			↻
Nuclear: access to all nuclear material types and forms	Acquire Jezebel plutonium	$	$
		↻	↻
Non-nuclear: access to all material types and forms	Sustain	$	$
		↻	↻

Table 3. IE Budget and Technical Priority Rankings (continued)

Process to manage experiments			
IE process (identify experiment need, evaluate experiment need, design experiment, conduct experiment, document experiment)	Continue improving the planning, performance, and evaluation of experiments in accordance with the process	$	$
		↻	↻
	Increase transparency of process	$	
		↻	
	Sustain process for use with non-NCSP operations	$	$
		↻	↻

6. Nuclear Data (ND)

6.1. ND Mission

The Nuclear Data (ND) program element includes measurement, evaluation, testing, and publication of nuclear reaction data for nuclides of high importance to nuclear criticality safety analyses. The objective is to solve the highest priority nuclear data problems relevant to criticality safety in a timely manner. This program element is essential for the NCSP because it provides the nuclear cross section data required by the AM program element. The NCSP continues to improve coordination of nuclear data activities by fostering a strong collaborative effort among all of our national and international resources in this highly technical area.

6.2. ND Vision

The ND element will sustain world-class expertise and capabilities to continually improve and disseminate measured and evaluated differential cross section and covariance data in a manner that is responsive to the needs of those responsible for developing, implementing, and maintaining criticality safety.

6.3. ND Strategy

The following strategy has been developed to direct the ND element toward achieving its vision. The ND element will:

- Actively engage the criticality safety practitioners to identify their nuclear data needs through various means of communication and will develop and disseminate ENDFs to meet those needs.
- Develop capabilities and perform high quality nuclear data measurements to address NCS data needs.
- Produce world-class nuclear data evaluations with covariances to address criticality safety data needs by developing and utilizing modern nuclear model codes with the best available experimental data.
- Test, validate, and disseminate nuclear data evaluations to continually improve the nuclear data available for the criticality end users.
- Disseminate nuclear data measurements and evaluations.
- Sustain the NCSP nuclear data capabilities and expertise through continual improvements of capabilities and mentoring of the next generation of leaders.
- Provide users with training and education on how the nuclear data they use is developed and the impact of new nuclear data on their work.

6.4. ND Technical Gap

A large majority of the previous 5-year goals were partially met and are ongoing. It is recognized that most of these previous goals were dual in nature, to perform priority measurements, evaluation and testing for the NCSP and to maintain capabilities in measurements, evaluation, and testing. The dual value of maintaining these goals will not only be carried forward into the new mission and vision, but it will also be made more explicit.

Although significant progress has been made in the ND program element, particularly in the areas of thermal neutron scattering and covariance data, additional work will be needed to sustain and improve on these accomplishments. Gaps in covariance data remain and will need to be filled, particularly for high-priority nuclides. Technical gaps related to ND evaluation capability include developing covariance evaluation methodologies for thermal scattering laws, URR cross sections, secondary energy/angle distributions, and correlations between fission observables, as well as developing a validation methodology for covariance data, supporting nuclear excitations (resonances) in TSL evaluation methodologies, and recapturing URR evaluation methods and tools. Technical gaps related to the ND measurement capability include measurement of angular distributions, sub-thermal total cross section, inelastic scattering cross section, and pulsed-neutron die-away measurements to validate TSL evaluations.

The international nuclear data community has initiated efforts to develop a new, modern ENDF/B data format that will become the international standard format for future nuclear data evaluations. Investment in the ND and AM elements will be needed to ensure that the NCSP can continue to provide nuclear data libraries to address priority NCS nuclear data needs.

Table 4. ND Budget and Technical Priority Rankings

Attributes	Goals	5y	10y
Personnel			
Differential data experimentalists	Develop and implement succession plans to maintain thermal, resonance region, and above-resonance-region differential measurement	$	$
Nuclear model developers	Develop and implement succession plans to maintain expertise in nuclear data analysis methods	$	$
Nuclear data evaluators	Develop and implement succession plans to maintain expertise in thermal, resonance region, and above-resonance-region evaluation	$	$
	Document best practices for nuclear data evaluations (knowledge management)	$	$
Nuclear data testers	Develop and implement succession plans to maintain expertise in data validation	$	$

Table 4. ND Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Differential measurements			
Access to and utilization of differential measurement facility(ies) and expertise	Develop and maintain existing US capabilities to perform total capture scattering and fission differential measurements	$	$
	Establish collaboration agreements with domestic and/or international programs, agencies, and institutions as needed to ensure access to differential measurement capabilities	$	$
Differential measurements of total, capture, fission, and scattering cross section data	Perform differential measurements on NCSP prioritized isotopes/nuclides	$	$
	Disseminate and document measured results, uncertainties, and covariance data needed to support the cross section evaluation effort	$	$
	Identify and prioritize differential measurements beyond the next five years	$	$
Differential measurements of thermal scattering law data for moderators	Develop new measurement capabilities (subthermal transmission, pulsed-neutron die-away) for thermal moderators at various temperatures	$	$
	Develop thermal data analysis capabilities needed to disseminate measured thermal data to evaluators	$	$
	Perform differential measurements on NCSP prioritized moderators	$	$

Table 4. ND Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Differential measurements (continued)			
Differential measurements of thermal scattering law data for moderators	Disseminate and document measured results, uncertainties, and covariance data needed to support the cross section evaluation effort	$	$
Models and calculations			
Capability to evaluate experimental data	Maintain existing resonance analysis and nuclear model software to analyze differential measured data and produce nuclear data evaluations with covariance data	$	$
	Develop and implement modernization plans for existing nuclear data analysis software (e.g., SAMMY, EMPIRE, GNASH)	$	$
	Develop and maintain evaluation capabilities to produce thermal scattering laws with covariance data	$	$
	Develop new analysis tools to fully utilize new experimental capabilities such as the time projection chamber (TPC), Chi-Nu, and correlated data	$	$
Evaluations			
Cross section and other nuclear reaction evaluations with covariance data for priority NCSP nuclear data needs	Complete cross section and other nuclear reaction evaluations, including required reaction channels energy ranges, and covariance data on NCSP-prioritized isotopes/nuclides per the NCSP Five-Year Plan	$	$
	Disseminate and document completed nuclear reaction evaluations as part of the current release of ENDF/B	$	$
	Identify and prioritize data evaluations beyond the next five years	$	$

Table 4. ND Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Evaluations (continued)			
Cross section and other nuclear reaction evaluations with covariance data for priority NCSP nuclear data needs	Develop and deploy a new, modern ENDF/B evaluation format to replace the aging ENDF-6 format	$	$
	Develop new evaluations with covariance data for fission product yields and delayed neutron data—will require re-establishing and sustaining expertise in this area	$	$
Data testing			
Accurate and reliable cross section evaluations disseminated to the end user	Use tools from the AM element and benchmark data (including the data of the ICSBEP element) to test the performance of new and existing cross section evaluations	$	$
	Report performance of evaluated data to nuclear data evaluator to improve quality of final nuclear data evaluations	$	$
Quantification and prioritization of target differential data needs to guide nuclear data measurement and evaluation work	Develop and maintain S/U analysis capabilities needed to prioritize NCSP nuclear data needs and quantify target accuracies needed for differential measurement and evaluation tasks	$	$
	Utilize S/U analysis capabilities to prioritize NCSP nuclear data needs and quantify target accuracies needed for differential measurement and evaluation tasks	$	$

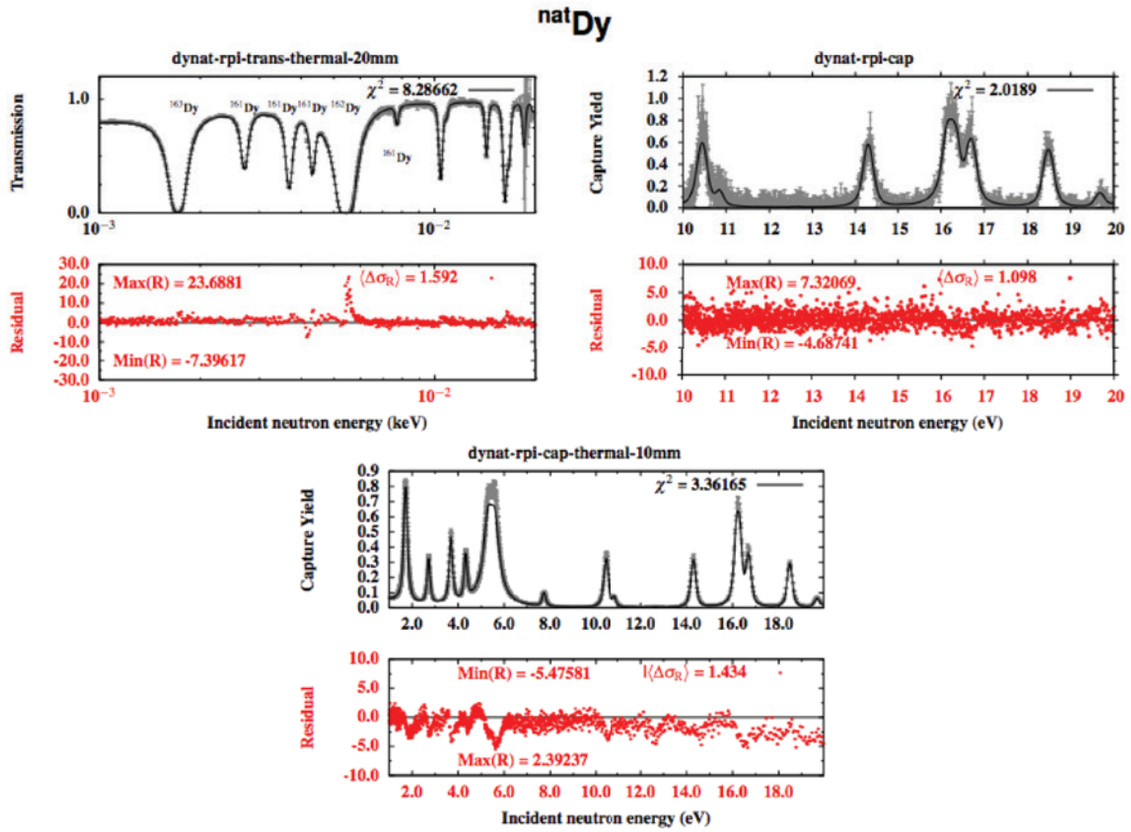


Figure 16. ORNL nuclear data evaluation results for Dy-nat.

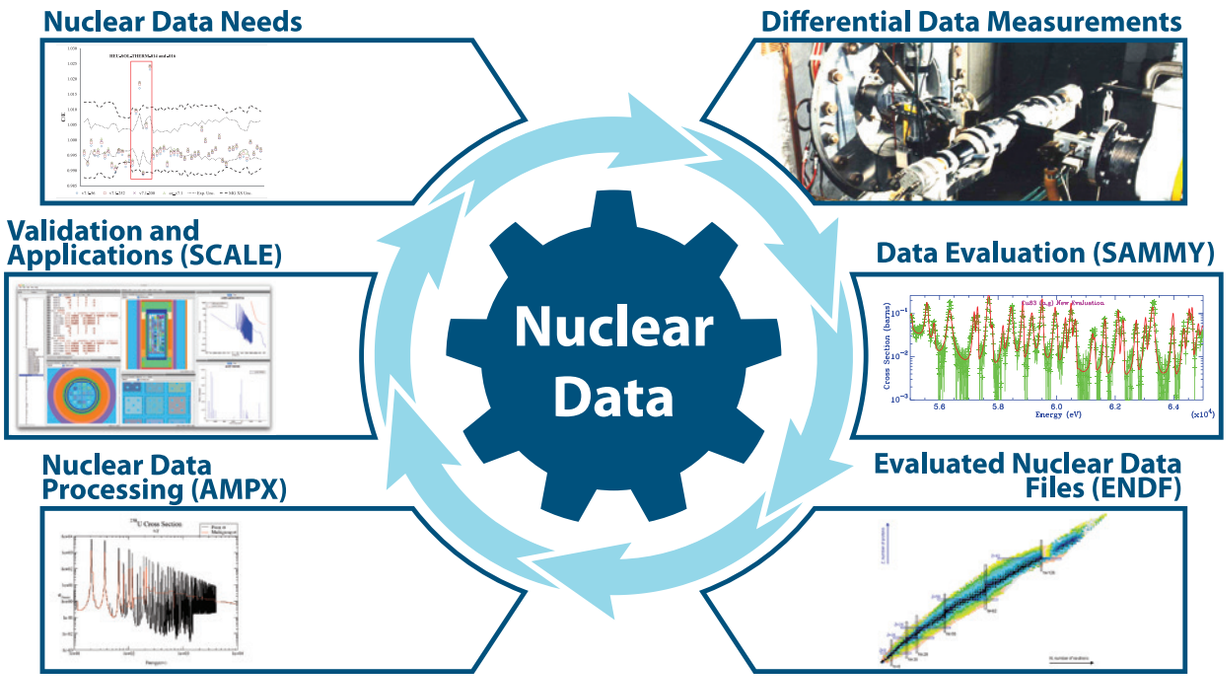
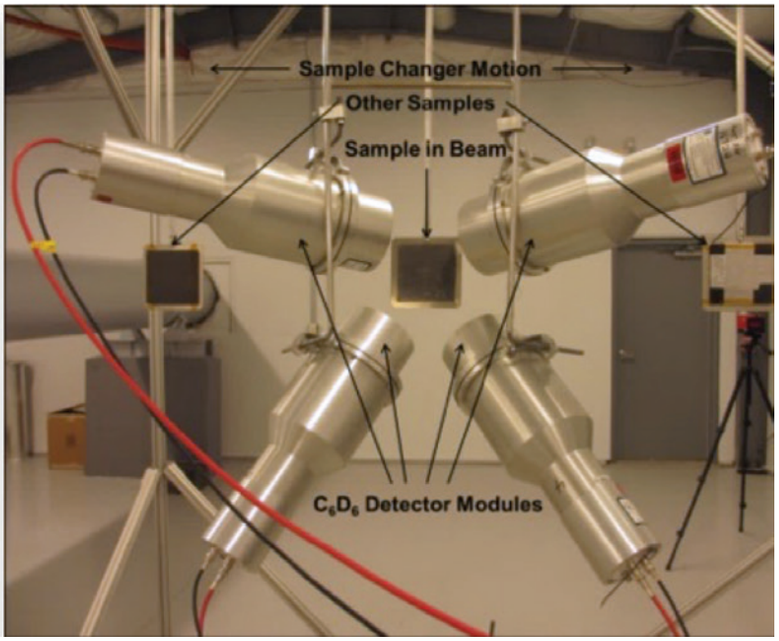


Figure 17. Nuclear data lifecycle: from identification of needs through validation and application analysis.



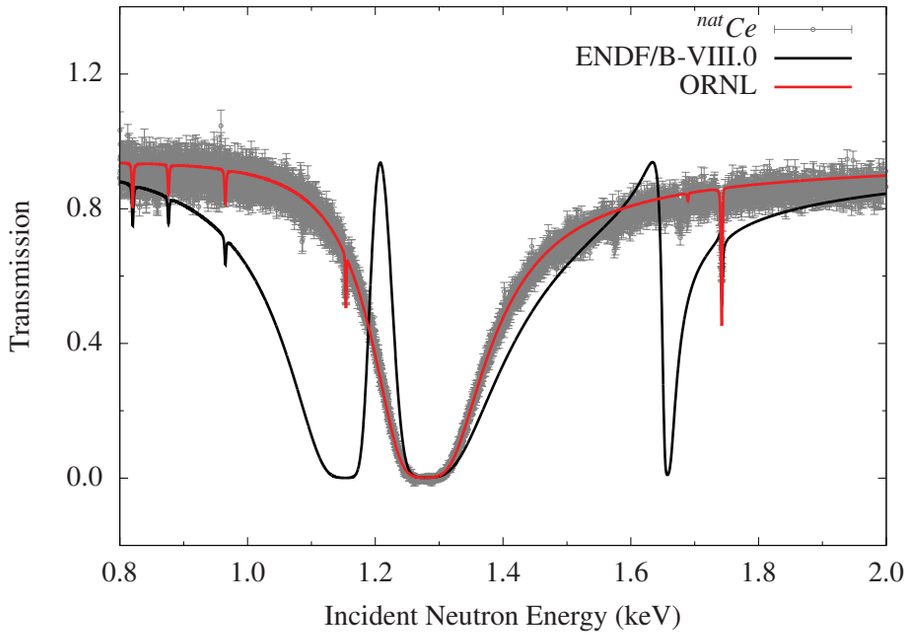


Figure 18. Example ND detectors and measurements.

7. Training and Education (TE)

7.1. TE Mission

The Training and Education (TE) program element will continue to identify, develop, and facilitate training needs and educational resources, including hands-on training with fissionable material systems, in areas where no suitable alternative exists. The primary purpose of the TE element is to maintain and enhance the technical abilities and knowledge of those who impact the practice of criticality safety, such as criticality safety engineers, criticality safety officers, managers, as well as those who are impacted directly by criticality safety, such as operators and process supervisors. This element includes training and education of people entering the criticality safety discipline from related scientific fields, who must maintain and enhance their competency levels to be commensurate with those already in the community.

7.2. TE Vision

The TE element will identify, develop, provide, and promote practical and excellent technical training and educational resources that help ensure competency in the art, science, and implementation of NCS and is **adaptable** and **responsive** to the needs of those responsible for developing, implementing, and maintaining criticality safety.

7.3. TE Strategy

The following strategy has been developed to direct the TE element toward achieving its vision. The TE element will:

- Continually evaluate qualification and knowledge expectations and communicate identified needs for training and education resources.
- Actively communicate, promote, and evaluate new and available training and education opportunities.
- Be responsive to identified training and education needs by developing and providing resources that sustain nuclear criticality safety capabilities and adequate oversight and awareness of criticality safety requirements.
- Provide sustainable, cost-effective, hands-on training in the behavior of fissionable material systems including those at or near critical conditions.
- Integrate training and education objectives through sharing of resources and information with national and international partners.
- Develop transparent processes to support efficient application of training and qualification of criticality safety engineers within criticality safety programs.

7.4. TE Technical Gap

The TE element has successfully drawn on the expertise of those throughout the DOE enterprise to establish and execute a sustainable one-week manager's NCS course and a two-week hands-on NCS practitioner's course that combines classroom and hands-on instruction using criticality systems at experimental facilities. An additional course for criticality safety officers and fissile material handlers with NCS responsibilities in process facilities is in development. In keeping with the TE mission statement to support operators and process supervisors, it is recognized that the bulk of this training is performed locally at the various sites. This training could be enhanced by developing training aides or information that can be deployed locally to make the training more effective, e.g., training simulators and deployable training aides.

The NCSP will continue to promote the awareness and training associated with application of modern S/U methods to support validation and other NCS efforts.

Providing improved methods and tools for evaluating training effectiveness will support ongoing enhancement of training and will help ensure that students can translate the learning experience to the workplace. Effective implementation of the TE vision has led to a broadening of the mission and strategy to seek enhanced collaboration on identification, utilization, and assessment of existing TE resources within the national and international community. The TE element will also allow for assessment of competency expectations and will provide a venue for suggestions or implementation of tools and processes to ensure that competency expectations are maintained in individuals and/or programs.

Goals that were not initiated or completed but that are still considered to be of interest to the NCS community were carried forward as 5- or 10-year goals. Based on an assessment of the current need to fulfill a goal, some TE goals were simply deleted. A number of training goals related to specialized training in cross section evaluation or processing (e.g., SAMMY, NJOY, PREPRO, and AMPX) were deemed to be components of sustaining subject matter experts and not relevant to general criticality safety practitioners; therefore, these goals remain in their applicable technical program elements.

Table 5. TE Budget and Technical Priority Rankings

Attributes	Goals	5y	10y
Personnel/facilities			
Access to an integrated, coordinated, and consistent compendium of criticality safety training and education resources that provide effective training commensurate with need	Implement a sustainable process to identify and communicate available training classes and education resources	$	$
		↻	↻
	Maintain a compendium of training and education resources accessible to the criticality safety community	$	$
		↻	↻
	Provide an integrated compendium of training and education resources that is coordinated for consistency across US agencies and institutions and accessible to the criticality safety community	$	$
		↻	↻
Collaborative environment among nuclear criticality safety communities	Cultivate and maintain university partnerships and international collaborations	$	$
		↻	↻
	Provide a sustainable program to facilitate national and international collaborative symposia and educational opportunities	$	$
		$	$
Efficient application of training and qualification of criticality safety engineers within criticality safety programs	Develop best practices through a review of training and qualification programs throughout the DOE complex to include approaches for assessment of competency	$	$
		↻	↻

Table 5. TE Budget and Technical Priority Rankings (continued)

Attributes	Goals	5y	10y
Personnel/facilities (continued)			
Provision of criticality safety training not readily available from other sources	Maintain and enhance the 2-week hands-on training provided by the NCSP to include tools and other training aids such as posters, training props, computer visualization aid, etc.	$	$
		↻	↻
	Develop and maintain deployable training for operators and process supervisors	$	$
		↻	↻
	Sustain a training course for managers, supervisors, and DOE facility representatives	$	$
		↻	↻
	Develop and maintain a training course for criticality safety officers and criticality safety representatives	$	$
		↻	↻
	Develop training classes, new training capabilities such as courses on subcritical assemblies, simulations, etc., NCSet modules, or tutorials based on a periodic gap analysis report of existing capabilities and community needs	$	$
		↻	↻

Figure 19. February 2017 Training and Education Course, Nevada Field Office, Las Vegas.

Figure 20. Student holding the beryllium-reflected plutonium (BeRP) ball (4.5 kg alpha-phase Pu metal) at NCERC, February 2018.

Glossary

AM	Analytical Methods
AWE	Atomic Weapons Establishment
BNL	Brookhaven National Laboratory
CAAS	criticality accident alarm system
CAD	computer-assisted design
CAE	computer-aided engineering
CAT	category
CEA	Commissariat à l'Énergie Atomique
CEdT	Critical/Subcritical Experiment Design Team
CS	criticality safety
CSCT	Criticality Safety Coordinating Team
CSEWG	Cross Section Evaluation Working Group
CSSG	Criticality Safety Support Group
CX	critical experiment
D&D	decontamination and decommissioning
DOE	US Department of Energy
ENDF	Evaluated Nuclear Data File
GNDS	Generalized Nuclear Data Structure
HTML	hypertext markup language
ICSBEP	International Criticality Safety Benchmark Evaluation Project
IE	integral experiment
IER	integral experiment request
IPD	Information Preservation and Dissemination
IRSN	Institut De Radioprotection et De Sûreté Nucléaire
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
MCNP	Monte Carlo N-Particle
MSTS	Mission Support and Test Services, LLC
MT	management team
NA-511	Office of Chief Defense Nuclea Safety
NASA	National Aeronautics and Space Administration
NCS	nuclear criticality safety
NCSET	nuclear criticality safety engineer training
NCSP	Nuclear Criticality Safety Program
NCERC	Nuclear Criticality Experiments Research Center
ND	Nuclear Data
NDAG	Nuclear Data Advisory Group
NNL	Naval Nuclear Laboratory
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
OECD	Organisation for Economic Co-operation and Development
ORNL	Oak Ridge National Laboratory
POC	point of contact
R&D	research and development
RPI	Rensselaer Polytechnic Institute
S/U	sensitivity/uncertainty
SNL	Sandia National Laboratories
SPR	Sandia Pulsed Reactor
SRS	Savannah River Site
SQA	software quality assurance
TE	Training and Education
TEX	thermal/epithermal experiment
TM	task manager
TPC	time projection chamber
TPR	technical program review
TS	Technical Support
TSL	thermal scattering law
USL	upper subcritical limit
URR	unresolved resonance range

APPENDIX A: FY2014–FY2023 Mission and Vision Accomplishment Summary

Tabulation of the Goals and Attributes of NCSP Technical Program Elements for the Second Mission and Vision Document

FY2014–FY2023

The progress made toward meeting the attributes and goals set forth in the FY2014–FY2023 Mission and Vision document for the Nuclear Criticality Safety Program (NCSP) is preserved in this document for archival and future out-year comparison. New goals and attributes tables are provided in the main body of this document within each program element. Progress on the FY2008–FY2013 Mission and Vision is documented in Appendix A of the FY2014–FY2023 Mission and Vision document.

The following tables summarize the goals and attributes of each NCSP program element as envisioned in the five- and ten-year periods for the period FY2014–FY2023. A check mark in the 5-year column indicates that the item or subitem is part of the Five-Year Plan, and a check mark in the 10-year column indicates that it is part of the longer term plan. In many cases, five-year items are carried over to the ten-year scope.

The revised Mission and Vision document for FY 2014–2023 is organized differently from the last document in that each program element section flows from the mission, vision, and attributes of a robust program element to five-year, ten-year, and stretch goals that if met will help sustain the attributes of a robust program. Furthermore, the new attributes and goals tables, which are now incorporated into the main body of this document within each program element, are color coded to depict a consensus of technical and budget priorities. As before, future revisions of this document will continue to provide the foundation for the NCSP five-year planning process.

The NCSP performance for the previous 5-year goals have been assessed as part of the 2018 Mission Vision revision effort, and an assessment of completion is provided below.

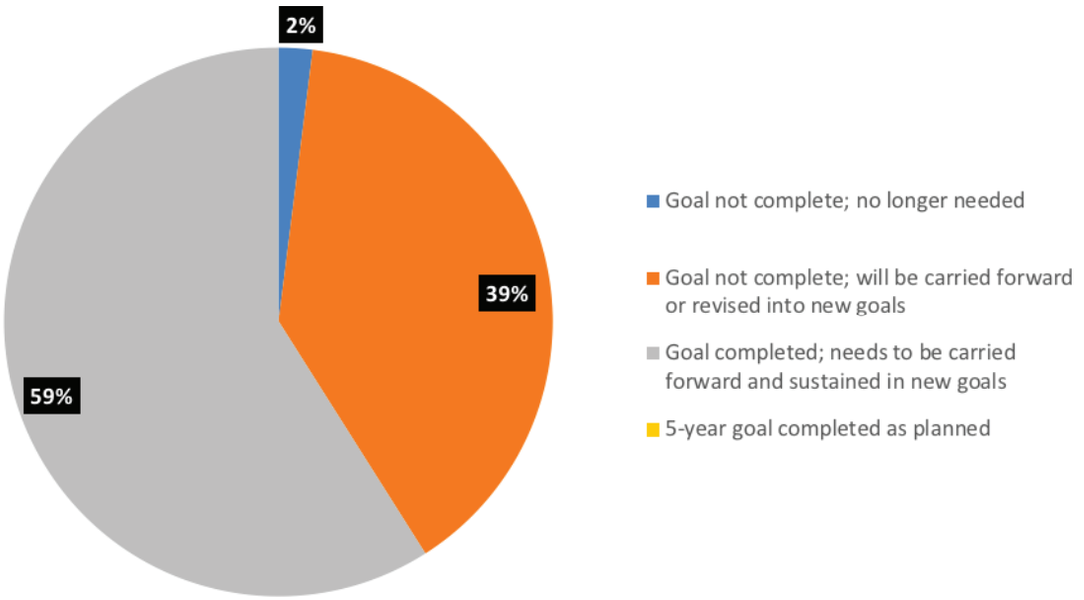


Figure A1. NCSP Mission and Vision goals: midterm assessment, FY2014–2023.

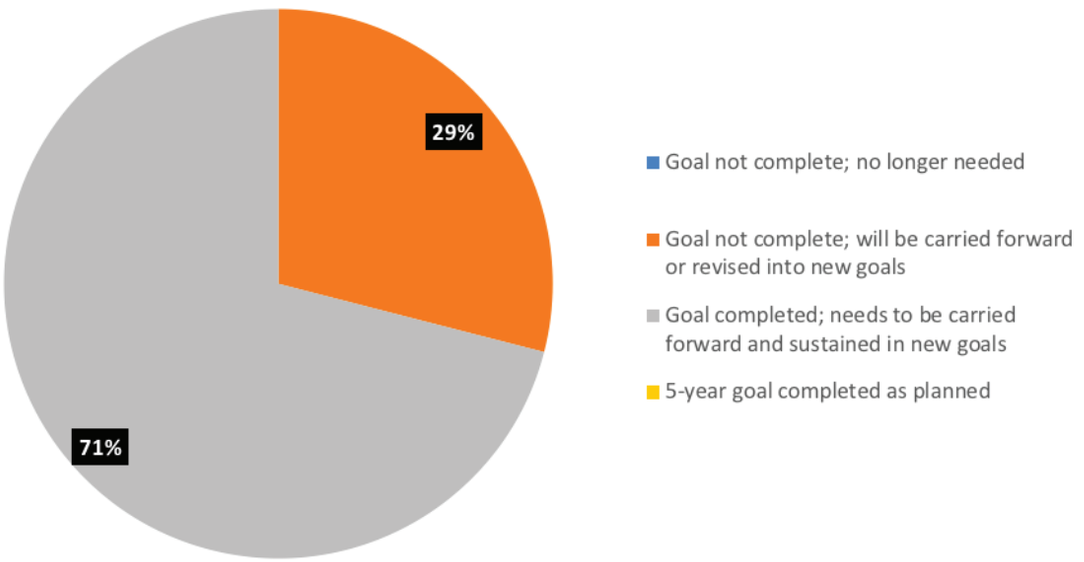


Figure A2. NCSP Analytical Methods goals: midterm assessment.

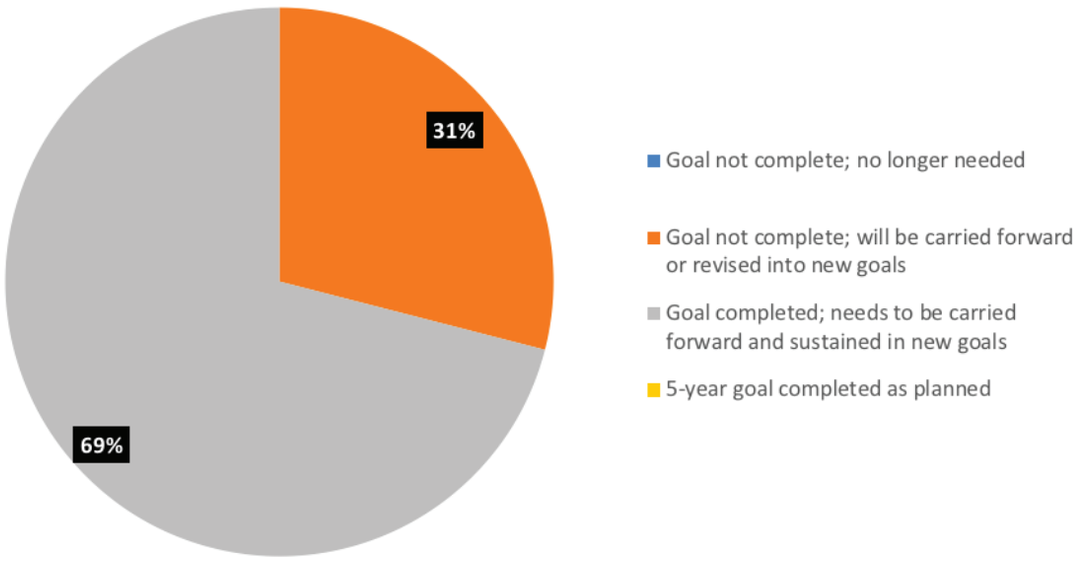


Figure A3. NCSP Information Preservation and Dissemination goals: midterm assessment.

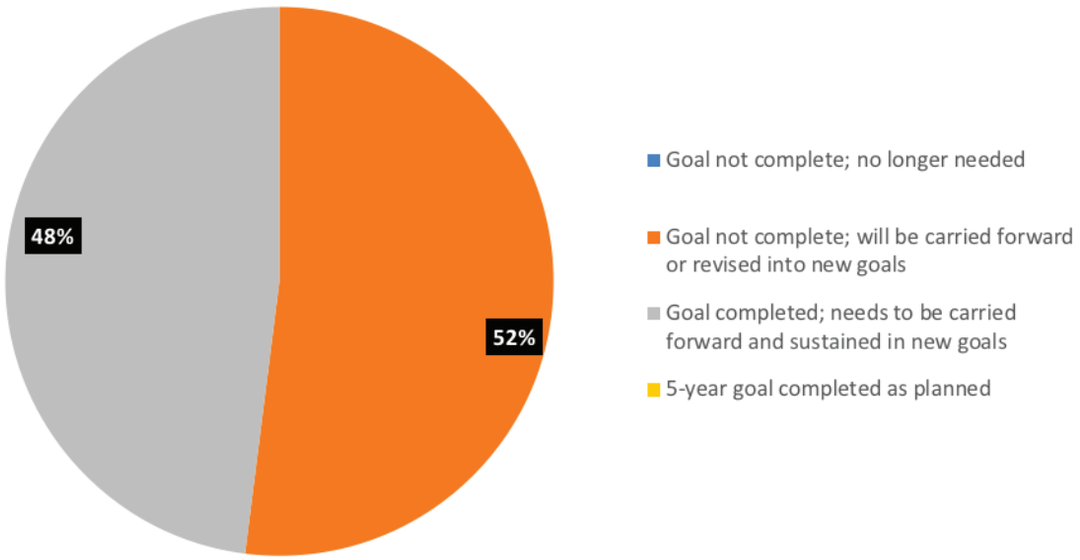
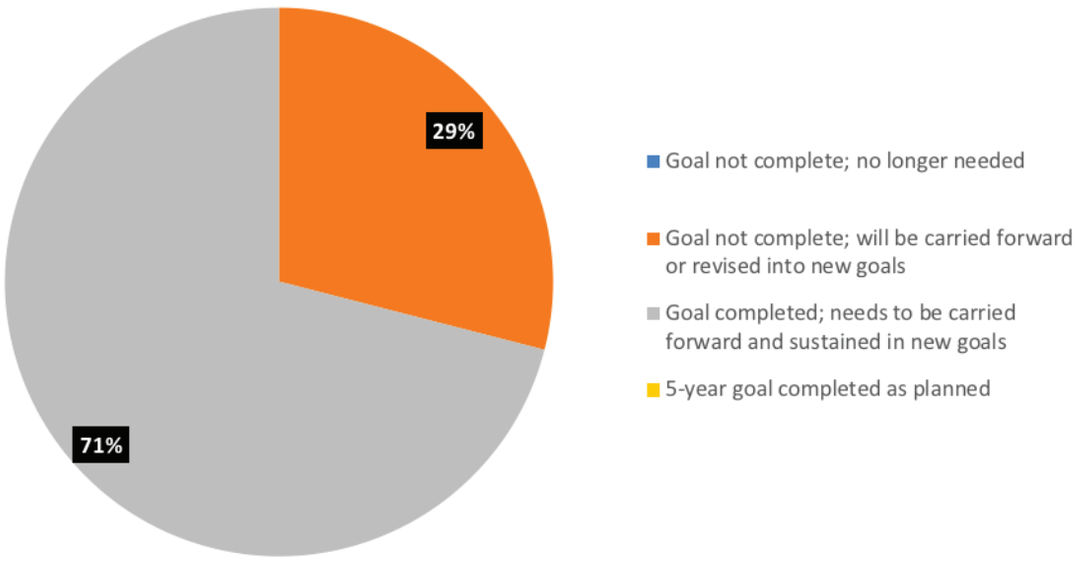


Figure A4. NCSP Integral Experiment goals: midterm assessment.



Fugure A5. NCSP Nuclear Data goals: midterm assessment.

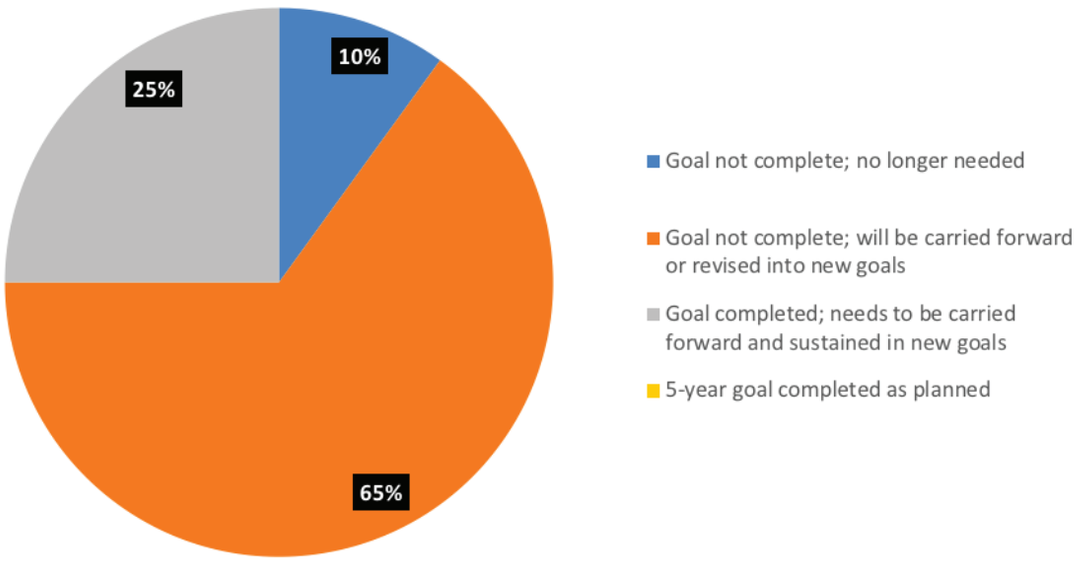


Figure A6. NCSP Training and Education goals: midterm assessment.

Table A.1. AM 5- and 10-Year Attributes and Goals

Attributes	Goals	5y	10y
Personnel			
Cross section processing developers	Develop and implement succession plans to maintain cross section processing expertise	✓	✓
Radiation transport developers	Develop and implement succession plans to maintain radiation transport expertise	✓	✓
Processing codes and data libraries			
Ability to process • Entering evaluations in standard formats from all international compilations • Reaction cross section/energy/angle • Covariances (reaction/energy/angle)	Develop and maintain more than one independent cross section processing code system	✓	✓
	Update processing codes to process new, modern ENDF/B data format	✓	✓
	Process new covariance evaluations for thermal scattering law data, collision kinematics, fission energy distributions	✓	✓
Ability to create code dependent libraries • Continuous-energy • Multigroup	Produce continuous-energy, multigroup, and covariance data libraries for use in radiation transport code systems	✓	✓
SQA of processing codes and libraries	Develop and maintain processing software and data libraries under SQA	✓	✓
	Develop and utilize comprehensive verification/validation suite to allow cross-code comparison of processing results from ENDF formats	✓	✓

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

Table A.1. AM 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Processing codes and data libraries (continued)			
Computational • Multiplatform • Multiple operating systems, compilers • Adaptable, sustainable (languages, etc.)	Deploy cross section processing code systems for operation on multiple computing platforms and operating systems	✓	✓
Radiation transport codes			
Solution method • Monte Carlo • Deterministic • Coupled Monte Carlo – Deterministic • Solution efficiency	Develop and maintain more than one independent radiation transport code system	✓	✓
	Develop and maintain coupled Monte Carlo – Deterministic capabilities to enable automated variance reduction capabilities	✓	✓
	Develop and maintain modern source convergence and variance reduction methods	✓	✓
Geometry • 1D → generalized 3D • CAD/CAE interface • Time dependence (e.g., Godiva ringing)	Provide and maintain radiation transport software with geometry modeling capabilities (1D to 3D) needed to support NCS analyses	✓	✓
	Couple modern NCS radiation transport software with CAD/CAE packages	●	✓
	Develop and maintain time-dependent geometry modeling capability	●	✓
Physics • Coupled neutron, photon • Eigenvalue/fixed source • Forward and adjoint • Time-dependent • Continuous-energy • Fine group, problem-dependent multigroup • Subcritical techniques • Depletion capability • Temperature dependence and feedback	Provide and maintain radiation transport software with the following capabilities to support NCS analyses: • Coupled neutron, photon transport • Eigenvalue/fixed source solution • Forward and adjoint solution Continuous-energy and multigroup solution	✓	✓
	Develop and deploy time-dependent radiation transport accident analysis capabilities	●	✓
	Develop and maintain NCS radiation transport software with temperature feedback	●	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.1. AM 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
S/U methods			
Ease of use • Documentation, including limited online help • Graphical user interface • Interoperability • Materials preprocessing	Develop and maintain the following capabilities: • Documentation, including limited online help • Graphical user interface • Interoperability • Materials preprocessing	✓	✓
	Provide regular training courses each year on the use of NCS software	✓	✓
Radiation transport software with modern output and modularity to facilitate NCS analyses	Develop and maintain NCS radiation transport software with the following capabilities: • Ability to link to other physics codes • Detailed physics edits, including detectors • Modern markup language (e.g., HTML) • Graphical displays • Flux, reaction rate edits • Generic multiphysics output (e.g., ABACUS)	✓	✓
SQA of transport codes	Develop and maintain radiation transport software and data libraries under SQA	✓	✓
Computational • Multiplatform • Multiple operating systems, compilers • Adaptable, sustainable (languages, etc.)	Deploy radiation transport systems for operation on multiple computing platforms and operating systems	✓	✓
Sensitivity analysis capabilities • Sensitivity profiles • Similarity assessment • Covariance data (differential, integral, computational)	Develop and maintain more than one independent S/U analysis software package	✓	✓
	Develop and deploy methods to provide integral experiment correlation data	✓	✓
	Provide correlation data for integral benchmark experiments	✓	✓
Data adjustment	Develop and maintain S/U data adjustment capabilities to support uncertainty analysis and bias quantification	✓	✓

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

Table A.1. AM 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
S/U methods (continued)			
Validation	Develop and maintain S/U capabilities to facilitate quantitative NCS validation analyses (e.g., similarity assessment, area of applicability determination, upper subcritical limit [USL] determination, etc.)	✓	✓
SQA of S/U codes	Develop and maintain radiation transport software and data libraries under SQA	✓	✓
Accident analysis			
Field-deployable emergency response methods on portable handheld platform	Develop and maintain modern accident analysis capability (SlideRule)	●	✓
3D accident analysis capability	Develop and deploy time-dependent multiphysics capabilities: • neutron transport • temperature feedback • hydrodynamics • time-dependent geometry • fluid-flow	●	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.2. IPD 5- and 10-Year Attributes and Goals

Attributes	Goals	5y	10y
Personnel/facilities			
Maintenance/development of unclassified and classified web-based repositories, with controlled access as needed for important data for criticality safety. Examples include but are not limited to: • ICSBEP benchmarks (including classified) • Critical experiment logbooks • Electronic handbooks and relevant criticality safety standards and data • Operational experience and training videos • Criticality safety professional phonebook	Implement and maintain periodic data call for available material: • Provide processes for evaluating available material for IPD value • Archive and disseminate training and operational videos (historical and current) • Preserve unclassified/classified topical references (e.g., waste drums, vault storage, onsite/offsite transport, criticality alarm placement, D&D)	✓	✓
	Maintain NCSP website to improve user interface and data retrievability	✓	✓

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

Table A.2. IPD 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Personnel/facilities			
Maintenance/development of unclassified and classified web-based repositories, with controlled access as needed for important data for criticality safety. Examples include but are not limited to: • ICSBEP benchmarks (including classified) • Critical experiment logbooks • Electronic handbooks and relevant criticality safety standards and data • Operational experience and training videos • Criticality safety professional phonebook	Operate and maintain a robust and secure infrastructure (e.g., web server hardware and software, NCERC "Red" network, etc.) to support information dissemination	✓	✓
	Develop and maintain searchable criticality safety professional phonebook; include site/facility criticality safety POC; include key words for experience/evaluation expertise	●	✓
	Implement a process to rapidly disseminate information (e.g., operational upsets, emergency response) to criticality safety professionals ("Crit spam")	●	✓
	Develop a long-term hardcopy archive of critical experiment logbooks, including eventual electronic versions	●	✓
	Maintain and publish (as an electronic newsletter) a US/international database of near misses, operational issues and lessons learned (historical/future)	●	✓
	Provide periodic reports on NCSP TPR to communicate and promote to the criticality safety related community (web-published and American Nuclear Society session)	✓	✓
	Identify and retain key data important to criticality safety	✓	✓
Partnership with national and international entities for data collection, evaluation, and preservation.	Participate in national and international ICSBEP information exchange programs and meetings	✓	✓
	Within ICSBEP, evaluate and review evaluations to assess the quality of available data to ensure data consistency and communication of discrepancies, publish unclassified and classified criticality safety benchmarks, including historical/future sensitivity studies	✓	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.3. IE 5- and 10-Year Attributes and Goals

Attributes	Goals	5y	10y
Personnel			
Experimentalists	Develop/implement succession plans	✓	✓
Equipment support personnel	Develop/implement succession plans	✓	✓
Facility support personnel	Develop/implement succession plans	✓	✓
Facilities			
Support to all security category nuclear material operations	Repair/maintain NCERC facility infrastructure to support IE mission	✓	✓
	Develop SNL facilities as IE assets	✓	✓
Support to all nuclear material types and forms	Develop authorization basis to support powders and solutions	✓	✓
Low-scatter facilities	Design and deploy low-scatter capabilities		✓
Machine shop hot/cold	Standup cold machine shop at NCERC	✓	✓
	Standup hot machine shop at NCERC		✓
Support to free-field experiments	Develop infrastructure to support free-field experiments		✓

- Goal not complete; no longer needed
- Goal not completed; will be carried forward or revised into new goals
- Goal completed and needs to be carried forward and sustained in new goals
- 5-year goal completed as planned
- ✓ Part of 5- and/or 10-year plan

Table A.3. IE 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Facilities (continued)			
Support to dynamic experiments	Develop infrastructure to support dynamic experiments	✓	✓
Low background counting area	Maintain low-background counting area at NNSS	✓	✓
Dosimetry laboratory	Design and deploy dosimetry laboratory at NNSS	✓	✓
Radiochemistry laboratory	Design and deploy radiochemistry laboratory at NNSS	✓	✓
Precision measurements laboratory	Install measurements laboratory at NCERC	✓	✓
Experiment equipment			
General purpose vertical lift machine	Investigate vertical lift assembly for SNL	✓	✓
Horizontal split table	Design horizontal split table	✓	✓
Fast burst reactor	Investigate restoring SPR-III to service	✓	
	Conceptual design of Np burst reactor	✓	✓
Solution reactor	Investigate solution reactor design and location	✓	✓
	Construct solution reactor	●	✓
Uranium lattice light water moderated (CX)	Maintain the Sandia Pulsed Reactor Facility / Critical Experiments (SPRF/CX) capability at SNL	✓	✓
Fast benchmark assembly	Maintain GODIVA-IV operability at NNSS	✓	✓
Rabbit system	Design and install rabbit system at NCERC	✓	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.3. IE 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Materials			
Nuclear: access to all nuclear material types and forms	Investigate acquisition of low-enriched metal (≤ 20% U)	✓	✓
	Investigate acquisition of Np metal	✓	
	Acquire Np metal		✓
Process to manage experiments			
Non-nuclear: access to all material types and forms	Maintain access to all non-nuclear material types and forms available with NCSP	✓	✓
Integral experiment request (IER) process (identify experiment need, evaluate experiment need, design experiment, conduct experiment, document experiment)	Plan, perform, and evaluate experiments in accordance with the Critical/Subcritical Experiment Design Team (CEdT) process	✓	✓
	Increase transparency of the IER process	✓	✓
	Adapt CEdT process for use with non-NCSP operations	✓	✓
Training			
Nonqualified personnel access to training with all security category nuclear material	Develop efficient process for access and escort of trainees at NCERC	✓	✓

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

Table A.4. ND 5- and 10-Year Attributes and Goals

Attributes	Goals	5y	10y
Personnel			
Differential data experimentalists	Develop and implement succession plans to maintain thermal, resonance region, and above-resonance-region differential measurement expertise	✓	✓
Nuclear model developers	Develop and implement succession plans to maintain nuclear data analysis methods expertise	✓	✓
Nuclear data evaluators	Develop and implement succession plans to maintain thermal, resonance region, and above-resonance-region evaluation expertise	✓	✓
Nuclear data testers	Develop and implement succession plans to maintain data validation expertise	✓	✓
Differential measurements			
Access to and utilization of differential measurement facility(ies) and expertise	Develop 20-year plan for US differential measurement capabilities and facilities needed to support NCSP measurement requirements		✓
	Develop and maintain existing US capabilities to perform total, capture, and fission differential measurements	✓	✓
	Establish collaboration agreements with domestic and/or international programs, agencies, and institutions as needed to ensure access to differential measurement capabilities	✓	✓
Differential measurements of total, capture, fission, and scattering cross section data	Perform differential measurements on NCSP prioritized isotopes/nuclides	✓	✓
	Disseminate and document measured results, uncertainties, and covariance data needed to support the cross section evaluation effort	✓	✓
	Identify and prioritize differential measurements beyond the next five years		✓

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

Table A.4. ND 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Differential measurements (continued)			
Differential measurements of thermal scattering law data for moderators	Develop new measurement capabilities for thermal moderators at various temperatures	✓	✓
	Develop thermal data analysis capabilities needed to disseminate measured thermal data to evaluators	✓	✓
	Perform differential measurements on NCSP prioritized moderators	✓	✓
	Disseminate and document measured results, uncertainties, and covariance data needed to support the cross section evaluation effort	✓	✓
Models and calculations			
Capability to evaluate experimental data	Maintain existing resonance analysis and nuclear model software to analyze differential measured data and produce nuclear data evaluations with covariance data	✓	✓
	Develop and implement modernization plans for existing nuclear data analysis software (e.g., SAMMY, EMPIRE, GNASH)	✓	✓
	Develop new evaluation capabilities to analyze measured thermal scattering data and produce thermal cross section evaluations with covariance data	✓	✓
	Develop new analysis tools to fully utilize new experimental capabilities such as the time projection chamber (TPC), Chi-Nu, and correlated data	●	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.4. ND 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Evaluations			
Cross section evaluations with covariance data for priority NCSP nuclear data needs	Complete cross section evaluations, including required reaction channels and energy ranges, and covariance data on NCSP-prioritized isotopes/nuclides per the NCSP Five-Year Plan	✓	✓
	Disseminate and document completed cross section evaluations as part of the current release of ENDF/B	✓	✓
	Identify and prioritize data evaluations beyond the next five years	●	✓
	Develop and deploy a new, modern ENDF/B evaluation format to replace the aging ENDF-6 format	✓	✓
	Develop advanced graphical user interface tools to facilitate dissemination, documentation, understanding of evaluated cross section data	●	✓
	Develop new evaluations with covariance data for fission product yields and delayed neutron data—will require re-establishing and sustaining expertise in this area	●	✓
Data testing			
Accurate, reliable cross section evaluations disseminated to the end-user	Use tools from the AM element and benchmark data, (including the data of the ICSBEP element) to test the performance of new and existing cross section evaluations	✓	✓
	Report performance of evaluated data to nuclear data evaluator to improve quality of final nuclear data evaluations	✓	✓
Quantification and prioritization of target differential data needs to guide nuclear data measurement and evaluation work	Develop S/U analysis capabilities needed to prioritize NCSP nuclear data needs and to quantify the target accuracies needed for differential measurement and evaluation tasks	●	✓
	Utilize S/U analysis capabilities to prioritize NCSP nuclear data needs and to quantify the target accuracies needed for differential measurement and evaluation tasks	●	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

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✓ Part of 5- and/or 10-year plan

Table A.5. TE 5- and 10-Year Attributes and Goals

Attributes	Goals	5y	10y
Personnel/facilities			
Access to an integrated, coordinated, consistent compendium of criticality safety training and education resources that provide effective training commensurate with needs	Implement a sustainable process to identify and communicate available training classes and education resources in the national and international community	✓	✓
	Perform a gap analysis of training needs based on an assessment of available training and education resources in the national and international community	●	✓
	Provide an integrated compendium of training and education resources that is coordinated for consistency across US agencies and institutions and accessible to the criticality safety community	●	✓
	Develop an integrated compendium of training and education resources coordinated with international partners to foster consistency on material and maximize use of unique resources	●	✓
	Foster a sustainable process to obtain and incorporate feedback to expand or improve training course(s), training modules, or nuclear criticality safety engineer training (NCSET) modules	✓	✓
Collaborative environment between national and international communities	Cultivate and maintain university partnerships	●	✓
	Provide a sustainable program (internship, rotational assignments, etc.) to facilitate collaborative training and education opportunities (national and international)	●	✓
	Provide collaborative training for experimenters in US and foreign facilities	✓	✓
Transparent qualification assessment of criticality safety engineers and/or criticality safety programs	Evaluate recommendations from a multi-lab team and select a qualification program approach, complete with criteria, benefits, and required resources	●	✓
	Implement a qualification program in a graded manner, for example, as part of training and qualification for next-generation criticality safety engineers and competency verification for current criticality safety engineers	●	✓

● Goal not complete; no longer needed

● Goal not completed; will be carried forward or revised into new goals

● Goal completed and needs to be carried forward and sustained in new goals

● 5-year goal completed as planned

✓ Part of 5- and/or 10-year plan

Table A.5. TE 5- and 10-Year Attributes and Goals (continued)

Attributes	Goals	5y	10y
Personnel/facilities			
Provider of criticality safety training not readily available from other sources	Ensure that the existing and unique training provided by the NCSP, such as classroom and hands-on experiment training and NCSET modules, remains a high priority	✓	✓
	Ensure that a criticality simulator is available to demonstrate criticality physics fundamentals to process operators	✓	✓
	Ensure that criticality simulator is available to simulate plant/process conditions and to simulate a walk-through; for example, a simulated facility could be staffed by role players (e.g., operators)	✓	✓
	Provide a mobile (CAT III or IV material) criticality hands-on critical or near-critical demonstration capability	✓	✓
	Provide a tutorial on subcritical methods and benchmark interpretation for nuclear criticality safety users	✓	✓
	Provide tutorials on criticality accident alarm system (CAAS) placement evaluation needs, as well as design options and considerations	✓	✓
	Provide a tutorial on D&D related to criticality safety	✓	✓
	Sustain a training course for managers, supervisors, criticality safety officers, or criticality safety representatives and DOE facility representatives	✓	✓
	Develop an NCSET module on the use of criticality safety accident SlideRule to support emergency response	✓	✓
	Develop a mobile CAT 1 criticality hands-on critical or near-critical demonstration capability		

Goal not complete; no longer needed	Goal not completed; will be carried forward or revised into new goals	Goal completed and needs to be carried forward and sustained in new goals	5-year goal completed as planned	Part of 5- and/or 10-year plan

APPENDIX B: Contributors to Preparation of the FY2019–FY2028 NCSP Mission and Vision

Table B.1. Technical Program Element Teams

Technical Program Element Teams				
Assignment	AM/ND	IPD	IE	TE
Lead	Mike Zerkle (NNL)	Lori Scott (NCSP)	Dave Hayes (LANL/CSSG)	Doug Bowen (ORNL)
Worker	Forrest Brown (LANL)	Jerry Hicks (CSSG)	Jeff Lewis (MSTS)	Fitz Trumble (AECOM/CSSG)
Worker	Brad Rearden (ORNL)	David Erickson (SRNS/CSSG)	Steve Clement (LANL)	Jesson Hutchinson (LANL)
Worker	Bob Little (LANL)	Mike Westfall (ORNL/CSSG)	Tim Beller (LANL)	Catherine Percher (LLNL)
Worker	Dave Heinrichs (LLNL)		John Scorby	Gary Harms (SNL)
Worker	Yaron Danon (RPI)		John Ford (SNL)	
Worker	Dave Brown (BNL)		Thomas Miller	
Advisors (CSSG as necessary)	Jerry McKamy (Ret./CSSG) Bob Wilson (DOE/CSSG) Mikey Brady-Rapp (Ret./CSSG) Jim Morman (ANL/CSSG) Kevin Kimball (Y12/CSSG) Tom McLaughlin (Ret./CSSG) Calvin Hopper (Ret./CSSG) Greg Sosson (DOE-EM/CSSG Ex-officio)			


Argonne
Rensselaer
Lawrence Livermore
BROOKHAVEN
NCERC
NNSA
MSTS
Sandia
Los Alamos
OAK RIDGE
Savannah River

History of the NCSP

Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 93-2 issued on March 23, 1993, addressed the need for a general-purpose critical experiment capability to ensure safety in handling and storage of fissionable material. Subsequently, DNFSB Recommendation 97-2 issued on May 19, 1997, addressed the need for improved criticality safety practices and programs to alleviate potential adverse impacts on safety and productivity of DOE operations. Recommendation 97-2 encompassed the ongoing Department activities of Recommendation 93-2 while broadening the scope to address important crosscutting safety activities needed to ensure nuclear criticality safety throughout the Complex. The DOE Implementation Plan for Board Recommendations 93-2 and 97-2 resulted in the establishment of the NCSP, and the ongoing criticality safety activities of the DOE have been performed under the NCSP that has been established per Board Recommendation 97-2. To implement Recommendation 97-2 in an integrated fashion, DOE took steps to ensure stable funding for the important crosscutting safety activities required by the recommendation. Further, effective implementation of the 97-2 crosscutting criticality safety activities under the NCSP is important to the successful completion of other DOE programs, such as those programs which address Board Recommendations 97-1, 94-1, 94-4, and 95-2.

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration